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OHIO RIVER POLLUTION SURVEY. VOLUME I. INTRODUCTORY AND GENERAL SECTIONS MAIN OHIO RIVER MINOR TRIBUTARY BASINS

Public Health Service
Cincinnati, Ohio

1942

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FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
CINCINNATI, OHIO
1942

OHIO RIVER POLLUTION SURVEY

FINAL REPORT
TO THE
OHIO RIVER COMMITTEE

VOLUME I

(Of Three Volumes)

INTRODUCTORY AND GENERAL SECTIONS
MAIN OHIO RIVER
MINOR TRIBUTARY BASINS

1798

Prepared at the request of the War Department
by the U. S. Public Health Service in cooperation
with the Corps of Engineers, U. S. Army.

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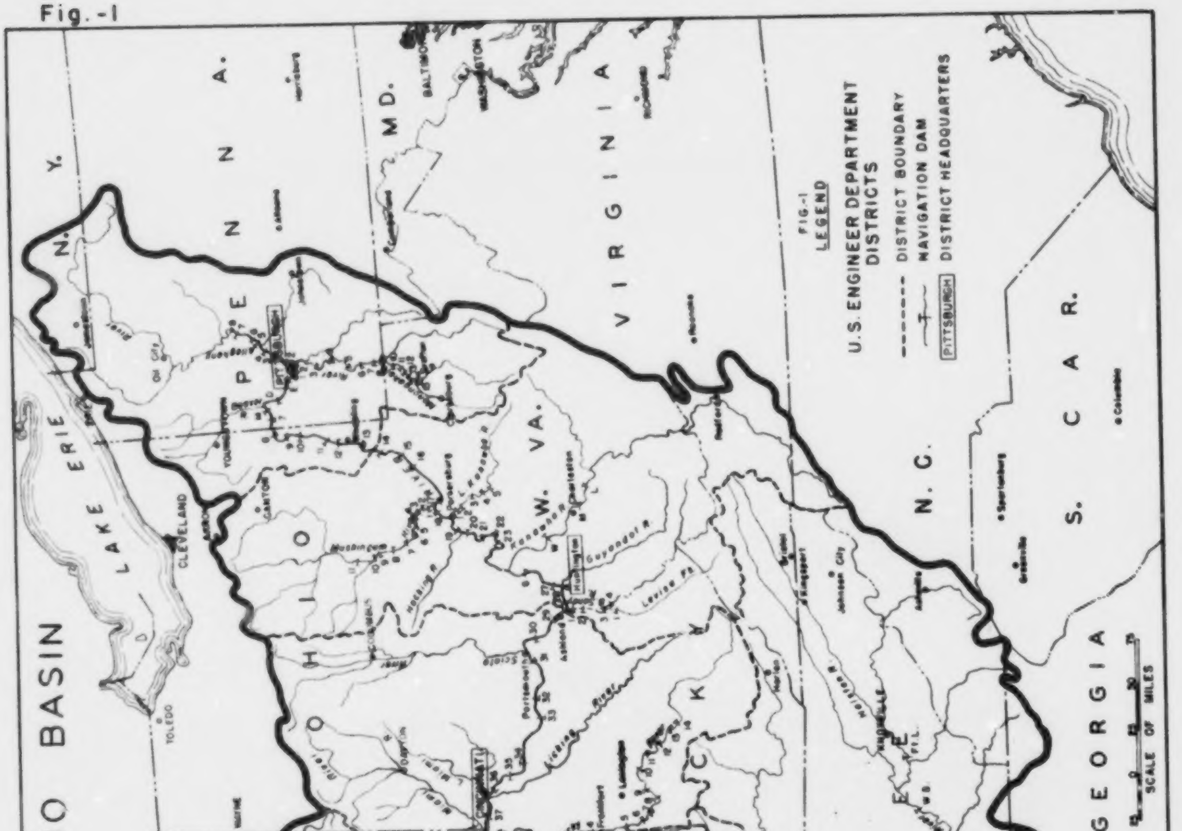
Fig.-1


OHIO BASIN
LAKE ERIE
FIG.-1
LEGEND
U.S. ENGINEER DEPARTMENT DISTRICTS
DISTRICT BOUNDARY
NAVIGATION DAM
PITTSBURGH
DISTRICT HEADQUARTERS
SCALE OF MILES
ILLINOIS
INDIANA
OHIO
PENNA.
N. Y.
MD.
W. VA.
VIRGINIA
KENTUCKY
TENNESSEE
N. C.
S. CAR.
GEORGIA
ALA.
MISS.
MO.
PITTSBURGH
HUNTINGTON
CINCINNATI
LOUISVILLE
NASHVILLE
CHICAGO
CLEVELAND
TOLEDO
SOUTH BEND
FORT WAYNE
ST. LOUIS
BALTIMORE
WASHINGTON
CHATTANOOGA
MEMPHIS
OHIO RIVER POLLUTION SURVEY
U S PUBLIC HEALTH SERVICE
MARCH 1942

SYLLABUS

The Ohio River Pollution Survey was directed by Section 5 of the River and Harbor Act, approved August 26, 1937, and subsequent authorizations by the Secretary of War, Secretary of the Treasury and Federal Security Administrator. This report presents information pertaining to sources, amounts and effects on various water uses of polluting material discharged into the watercourses of the 204,000 square miles of the Ohio River Basin and includes cost estimates for comprehensive pollution control measures.

The work of this survey has included locating all important sources of pollution and ascertaining the amount of polluting material discharged at each, measuring the present effects of the wastes on the streams by means of physical, chemical, bacteriological and biological examinations, determining the present and prospective uses of the streams, estimating the effects of changes in stream flows and river conditions and of possible future additional pollution, and determinin the degree of pollution abatement, by treatment, low-flow regulation, or other methods, which seems economically justified in the light of present and prospective stream uses. This has necessitated studies of water quality requirements for various uses, of available techniques for correcting various types of pollution and their cost, of disease outbreaks suspected of being waterborne , and of legal and administrative instruments and methods available for effecting pollution abatement.

Besides furnishing water for more than 7,000,000 persons and for industrial processes, the streams of the Ohio River Basin are used for the disposal of sewage by some 3,500,000 people and almost two-thirds of this sewage receives no treatment. Industrial wastes with an oxygen demand equivalent to sewage from almost 10,000,000 additional persons enter the streams. Pollution problems are further complicated by the effect of waters containing 1,800,000 tons of acid per year which flow or are pumped from active and abandoned coal mines in the extensive coal fields of the basin.

Many water supplies, both domestic and industrial, suffer from the effects of these polluting substances and outbreaks of intestinal diseases, apparently water-borne, have occurred following periods of low stream flow. Recreation facilities have been damaged. Fish and other aquatic life have been detrimentally affected. Steamboats, barges, other river craft and structures, pumps, pipe lines and condensers exposed to acid stream waters have been attacked.

Although the Ohio Basin, considered as a whole, is one in which water pollution is serious, the intensity of the problem is far from uniform. Many of the streams receive no wastes of consequence while others could be restored to good sanitary condition at a reasonable cost. Large concentrations of population or of industries and the present need for the development of more economical methods of correction of pollution from certain types of industrial wastes are practical considerations which will delay the attainment of a high degree of stream restoration in a few areas. Continued intensive research to develop better treatment or recovery techniques is essential in certain instances if conditions are to be improved. The results of this survey have made it more than ever apparent that it is neither practicable nor desirable to establish either uniform or permanent standards of water quality applicable to all streams throughout an area as extensive and varied as the Ohio Basin. On the other hand, some degree of treatment of all municipal sewage seems to be a reasonable requirement in an area as highly urbanized and densely populated as the Ohio Basin even though harmful effects are confined to possible odors, sludge deposits, floating sewage solids and scum in the immediate vicinity of the outfall.

Low-flow regulation by reservoirs can be used as an important supplement to treatment and other corrective measures in abating sewage and organic industrial waste pollution and in reducing mine acid surges. Proposed and existing flood control reservoirs in the area above Pittsburgh, those under construction on the Mahoning, New and Cumberland Rivers, and the proposed reservoir on the Olentangy River above Columbus, Ohio, are among those with outstanding value for pollution control. Others will have minor value. In general, the cost of providing storage exclusively for pollution control is not warranted by the benefits although this does not hold true in certain instances. If the regulated flow can be made available incidental to some other reservoir use, such as power or flood control, the value of the flow regulation for pollution abatement may be a factor in determining the economic justification of the reservoir project.

There appears to be both a need and a desire for abatement of water pollution in the Ohio Basin. About half of the sewage entering tributary streams, except at Ohio River cities, such as Pittsburgh and Cincinnati, now is being treated. However, a negligible part of the sewage from Ohio River communities is treated and this stream serves as a source of water supply for more than 1,600,000 people. The provision of sewage treatment facilities at Pittsburgh, Cincinnati and Louisville and various measures for the correction of mine acid pollution, principally in the upper Ohio River regions, are outstanding projects in the suggested basin-wide program for pollution abatement.

Salient features of the main Ohio River and the five Ohio River Division Districts of the U. S. Engineer Department and their pollution problems are as follows:

> Main Ohio River - A negligible part of the sewage from Ohio River communities is treated and this stream serves as a source of water supply for more than 1,600,000 people. One of the major factors which has delayed waste treatment on the Ohio River while rapid progress was being made elsewhere is the interstate character of the stream. In general, the state agencies concerned with water pollution lack authority over waste discharges to the Ohio River. An attempt is being made to correct this situation by means of an interstate compact, the Ohio River Valley Water Sanitation Compact, which has been approved by the Congress and ratified unconditionally by four states and with reservations by two others. Ratification, by the Pennsylvania legislature, is necessary before the compact can become effective. Since this is the first attempt that has been made to deal with interstate pollution problems in any large area in this manner, ratification by Pennsylvania is highly desirable in order that the compact may become operative and that this method of administrative control may be tested.
>
> Pittsburgh District (Allegheny, Monongahela and Beaver River Basins) - The tributaries in the Pittsburgh Engineer District receive about two-thirds of all the acid mine drainage in the Ohio Basin. Large amounts of untreated sewage from Pittsburgh and its suburbs enter the lower Monongahela and Allegheny Rivers and untreated sewage and industrial wastes from the Youngstown district seriously pollute the Mahoning and Beaver Rivers. Industrial wastes from a pulp mill and tanneries cause severe pollution along the Clarion River in spite of extensive measures taken to reduce the quantity and strength of these wastes. Phenols from by-product coke plants along the Mahoning cause obnoxious tastes and odors in water supplies from the Beaver River.
>
> Low-flow augmentation by reservoirs on tributaries of the Allegheny and Monongahela will be valuable supplements to mine sealing and sewage treatment programs

in abating pollution and the Berlin Reservoir, now under construction on the upper Mahoning, will relieve the shortage of cooling and process water for industrial use in the Youngstown area, in addition to supplementing waste treatment works for pollution control.

Huntington District (Muskingum, Little Kanawha, Hocking, Kanawha, Guyandot and Big Sandy River Basins) - The principal areas of heavy pollution in the Huntington Engineer District are the northern part of the Muskingum Basin and the lower Kanawha River from Charleston downstream. The remaining parts of the Muskingum and Kanawha River Basins as well as the Little Kanawha, Hocking, Guyandot and Big Sandy Basins and the minor tributaries are relatively clean. A number of the streams are polluted locally by mine drainage and untreated sewage but the communities are not large and the streams generally have sufficient natural alkalinity so that the effects of mine acid are not felt in the larger streams.

The upper Tuscarawas, headwater stream of the Muskingum River Basin, and some of its tributaries are heavily polluted by sewage and industrial wastes although steps have been taken to correct conditions. Waste salts on the upper Tuscarawas make that stream unsuitable as a source of water supply and for some other purposes for many miles. Chemical plants along the Kanawha River in the Charleston area are among the largest sources of pollution in the Ohio Basin. These wastes, together with untreated sewage from the cities in the same area, cause nuisance conditions in the river and serious taste and odor difficulties at water supplies downstream. Low-flow control by the Bluestone Reservoir now under construction on the New River will be of supplementary value in abating organic but not taste and odor pollution from this area.

Cincinnati District (Scioto, Little Miami, Licking, Miami and Kentucky River Basins) - More than 80 percent of the sewage from communities on tributaries in the Cincinnati Engineer District is treated. The most heavily polluted tributary in the District is the lower Miami River. Two of the larger cities on the lower Miami discharge untreated sewage but a major part of the pollution load comes from paper mills. Adequate pollution abatement will require research to develop more efficient methods of treating these wastes. Low-flow regulation for pollution abatement does not appear promising since present minimum flows are relatively high, and significant increases in these flows would require large storage capacities at high costs.

In spite of the recently constructed complete treatment plant at Columbus, the Scioto River is still polluted. There are many times when there is practically no dilution for the treatment plant effluent. Low-flow control by the proposed flood-control reservoir on the Olentangy River above Delaware would aid considerably in solving this problem. Strawboard plant wastes pollute the Scioto below Circleville, although the recently completed treatment plant has helped the situation. There is an urgent need for improved methods of treating these wastes and paper mill wastes. The Licking and Little Miami Rivers receive considerable amounts of untreated sewage and industrial wastes near their mouths in the Cincinnati metropolitan area. These should be intercepted and discharged after treatment to the Ohio River. Such a program is under way on the Little Miami. The outstanding sources of pollution in the Kentucky River Basin are distilleries, a number of which need improved waste disposal facilities. In general, the Licking, Kentucky and Little Miami are relatively clean streams.

Louisville District (Salt, Green and Wabash River Basins) - The Wabash River is the largest stream in the Louisville Engineer District and the only one with a major pollution problem. The Salt and Green River Basins are relatively clean although some of the distilleries in the Salt Basin have inadequate waste disposal facilities.

About three-quarters of the sewage from communities in the Wabash River Basin is treated. The largest municipality discharging untreated sewage is Terre Haute. Industrial wastes, particularly from vegetable canneries and strawboard plants, cause the most serious problems at present. The West Fork of White River is rather heavily polluted by wastes from Indianapolis, Muncie and Anderson, although all of these communities have sewage treatment plants. There are no suitable reservoir sites above these cities which could be used for low-flow control. Improvements to the Indianapolis treatment plant are needed to improve conditions in the West Fork.

Nashville District (Cumberland and Tennessee River Basins) - More than half of the pollution load in the Cumberland Basin enters the main stream in the vicinity of Nashville, the only large city in the basin. About one-half of the sewage outside of Nashville is treated at present. Under present unregulated flow conditions, secondary treatment would be required at Nashville in order to maintain satisfactory stream conditions. Upon completion of the Wolf Creek Reservoir, now under construction on the upper Cumberland, the minimum flow at Nashville will be sufficient to permit maintenance of satisfactory conditions with only primary treatment.

The Tennessee River Basin is a predominantly rural area which is experiencing a considerable industrial development due in a large degree to the program of the Tennessee Valley Authority. Scant progress has been made toward pollution abatement. The largest cities and principal industrial centers are Chattanooga, Knoxville and Asheville, all of which discharge sewage and other wastes without treatment. Most of the other important sources of pollution are on tributary streams in the upper half of the basin. Pulp, paper, chemical and textile wastes account for the bulk of the industrial waste load.

The program of the Tennessee Valley Authority has increased the low flow of the main stream and some of the tributaries, and further increases will result from reservoirs now under construction and those proposed but, with the exception of Chattanooga and Knoxville, the important sources of pollution are upstream from reservoirs and will not be helped by the increased flow. Additional effort is needed to improve methods now available for treating some of the industrial wastes.

The problem of financing the necessary facilities has always been one of the principal deterrents to pollution abatement. The effectiveness of grants-in-aid and low interest loans in accelerating such work has been proved by the experience of the past seven years. It seems doubtful that any such rapid progress will continue without aid from either the Federal or the State governments.

Table 1 summarizes some of the more important facts about the Ohio Basin. The cost estimates of waste treatment facilities include both interceptors and treatment plants. The estimated capital cost of the suggested program, including a mine sealing program, is approximately $180,000,000 and annual charges for operation, interest and amortization approximately $18,500,000. Cost estimates are based on average experience from 1928 to 1940. Costs for 1942 would be considerably higher and future costs will probably be subject to further change, depending upon fluctuations in construction costs for this type of work.

Table 1 - Ohio River Basin - Summary of Dat
Wastes, Costs of Existing and Sugg

	Mileage of Confluence with Ohio R.	Drainage Area Square Miles	Population - 1940			Public Water Supplies				Population Served by Sewers			
						Total All Supplies		Polluted Surface Supplies		Treatment			Tot
			Urban	Rural	Total	No.	Pop. Served	No.	Pop. Served	None	Primary	Secondary	
BY BASINS													
Main Ohio River			2,570.5	127.2	2,697.7	121	2,172.2	30	1,663.0	2,069.7	6.1	16.4	2,09
Minor Tributaries		23,780	130.4	1,254.8	1,385.2	94	213.7	9	24.6	57.5	13.9	96.4	16
Pittsburgh Eng. Dist.													
Allegheny	981.0	11,730	523.5	713.2	1,236.7	225	1,545.8	21	920.1	755.5	109.0	55.3	91
Monongahela	981.0	7,380	585.1	679.6	1,264.7	153	878.2	57	684.3	796.1	45.8	20.3	86
Beaver	955.6	3,145	477.3	251.1	728.4	50	554.1	12	430.4	297.3	134.3	84.1	51
Huntington Eng. Dist.													
Muskingum	808.8	8,040	398.4	413.6	812.0	94	471.2	4	74.5	137.0	78.7	206.9	42
Little Kanawha	796.4	2,320	-	92.4	92.4	8	10.0	3	2.9	5.4	1.4	3.4	1
Hocking	781.7	1,185	48.1	65.5	113.6	16	51.0	0	0	24.4	1.3	22.7	4
Kanawha	715.3	12,300	175.5	659.3	834.8	180	326.4	33	151.7	177.0	20.9	28.6	22
Guyandot	675.8	1,670	8.2	140.1	148.3	89	61.5	5	12.9	23.9	0	0	2
Big Sandy	663.9	4,280	31.2	380.7	411.9	120	137.5	15	44.3	52.4	0	2.6	5
Cincinnati Eng. Dist.													
Scioto	624.5	6,510	447.8	291.8	739.6	44	479.7	3	345.5	11.1	43.9	357.6	41
Little Miami	516.9	1,755	24.0	111.5	135.5	21	39.1	2	1.5	85.1	8.1	16.5	10
Licking	510.8	3,670	27.8	161.5	189.3	17	37.9	5	23.0	14.0	0	11.2	2
Miami	489.9	5,385	502.1	328.4	830.5	64	602.1	2	24.5	128.1	89.0	333.4	55
Kentucky	435.2	6,940	96.1	385.9	482.0	38	151.0	10	113.3	35.9	1.2	68.2	10
Louisville Eng. Dist.													
Salt	351.1	2,890	16.0	123.9	139.9	17	27.1	5	4.3	3.2	1.7	15.4	2
Green	196.8	9,220	44.4	400.0	444.4	39	69.9	9	23.4	10.7	29.3	5.0	4
Wabash	133.0	33,100	1,198.1	1,310.5	2,508.6	275	1,299.1	30	687.5	297.7	39.1	782.9	1,11
Nashville Eng. Dist.													
Cumberland	60.6	18,000	277.7	851.3	1,129.0	92	368.0	16	239.4	173.0	9.3	55.0	23
Tennessee	46.5	40,600	631.9	1,859.4	2,491.3	244	871.1	23	394.7	492.9	41.8	56.6	59
TOTAL		203,900	8,214.1	10,601.7	18,815.8	2,001	10,366.6	294	5,865.8	5,647.9	674.8	2,238.5	8,56
BY STATES													
Alabama		6,810	72.5	310.5	390.0	21	83.7	5	39.7	58.6	4.4	0	6
Illinois		11,440	214.3	386.2	600.5	70	232.2	14	103.5	53.1	29.8	120.5	20
Indiana		29,135	1,242.0	1,261.4	2,503.4	262	1,379.6	26	744.7	439.8	10.5	713.9	1,16
Kentucky		39,375	837.5	1,953.3	2,790.8	232	1,114.4	55	819.3	650.4	49.2	149.4	84
New York		1,955	76.4	73.0	149.4	25	119.3	1	24.0	29.5	79.5	1.5	11
North Carolina		6,260	67.7	287.0	354.7	55	124.9	1	0.2	98.0	1.5	3.5	10
Ohio		29,570	2,470.2	1,656.4	4,126.6	301	2,796.2	26	1,433.3	1,379.3	239.0	975.5	2,59
Pennsylvania		15,620	1,992.9	1,425.7	3,418.6	355	2,654.2	66	1,630.3	1,827.1	200.3	159.4	2,18
Tennessee		33,645	666.9	1,487.3	2,154.2	150	850.8	22	573.3	452.9	24.0	76.7	55
Virginia		7,175	62.3	393.1	455.4	84	127.2	5	11.3	44.1	8.6	5.9	5
West Virginia		20,610	500.9	1,276.7	1,777.6	435	876.3	73	486.2	609.1	25.9	28.7	66
Ga., Md., Miss.		2,305	3.5	91.1	94.6	11	7.8	0	0	6.0	2.1	3.5	1
TOTAL		203,900	8,214.1	10,601.7	18,815.8	2,001	10,366.6	294	5,865.8	5,647.9	674.8	2,238.5	8,561

NOTE: All populations, population equivalents and costs are in thousands. Capital cost figures rounded to nearest $10,000. Annual cost figures rounded to nearest $5,000.

Ohio River Basin - Summary of Data on Population, Public Water Supplies, Sewerage, Sewage Treatment, Industrial Wastes, Costs of Existing and Suggested Waste Treatment Facilities and Mine Sealing by Basins and States.

Population Served by Sewers				Number of Sewage Treatment Plants			Industrial Wastes Population Equivalent (BOD)			Total Population Equivalent (BOD)		Estimated Costs of		
Treatment			Total	Pri.	Sec.	Total	To Municipal Treatment	Not to Municipal Treatment	Total	Before Treatment	As Discharged	Existing Municipal		Suggested Municipal
None	Primary	Secondary										Capital	Annual	Capital
2,069.7	6.1	16.4	2,092.2	4	16	20	-	2,392.0	2,392.0	4,484.2	4,468.4	1,080	95	67,910
57.5	13.9	96.4	167.8	12	30	42	0.9	30.3	31.2	199.0	110.9	3,800	330	2,510
755.5	109.0	55.3	919.8	22	19	41	5.2	673.2	678.4	1,598.2	1,514.4	5,460	410	10,020
796.1	45.8	20.3	862.2	13	7	20	2.0	424.3	426.3	1,288.5	1,254.7	1,500	115	12,140
297.3	134.3	84.1	515.7	17	18	35	11.8	152.6	164.4	680.1	558.4	4,760	415	4,960
- - -	- - -	- - -	- - -	- -	- -	- -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
137.0	78.7	206.9	422.6	13	18	31	40.1	280.5	320.6	743.2	492.2	4,550	440	4,870
5.4	1.4	3.4	10.2	1	1	2				10.2	6.8	190	15	210
24.4	1.3	22.7	48.4	2	2	4	1.4	7.2	8.6	57.0	36.0	840	70	620
177.0	20.9	28.6	226.5	6	6	12	11.1	1,479.1	1,490.2	1,716.7	1,675.1	1,300	115	5,000
23.9	0	0	23.9	0	0	0	0	0.2	0.2	24.1	24.1	0	0	530
52.4	0	2.6	55.0	0	3	3	0	0.4	0.4	55.4	53.3	70	10	1,240
- - -	- - -	- - -	- - -	- -	- -	- -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
11.1	43.9	357.6	412.6	15	18	33	348.6	77.3	425.9	838.5	251.4	12,890	1,090	930
85.1	8.1	16.5	109.7	3	8	11	2.8	57.9	60.7	170.4	149.1	530	55	530
14.0	0	11.2	25.2	0	2	2	0	3.3	3.3	28.5	18.9	290	30	700
128.1	89.0	333.4	550.5	10	21	31	166.2	235.3	401.5	952.0	482.7	9,380	745	3,680
35.9	1.2	68.2	105.3	3	10	13	32.9	98.5	131.4	236.7	150.4	1,370	155	1,130
- - -	- - -	- - -	- - -	- -	- -	- -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
3.2	1.7	15.4	20.3	1	7	8	0.7	96.2	98.9	119.2	105.3	670	80	210
10.7	29.3	5.0	45.0	8	3	11	1.4	2.4	3.8	48.8	33.8	450	55	780
297.7	39.1	782.9	1,119.7	10	74	84	547.5	1,224.5	1,772.0	2,391.7	1,818.9	16,650	1,600	12,830
- - -	- - -	- - -	- - -	- -	- -	- -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
173.0	9.3	55.0	237.3	7	10	17	17.9	240.6	258.5	495.8	430.7	1,660	165	6,870
492.9	41.8	56.6	591.3	26	18	44	5.4	1,300.6	1,306.0	1,897.3	1,832.6	2,750	250	22,870
5,647.9	674.8	2,238.5	8,561.2	173	291	464	1,195.9	8,778.4	9,974.3	18,535.5	15,468.1	70,190	6,240	160,340
58.6	4.4	0	63.0	2	0	2	0.3	9.1	9.4	72.4	70.7	140	10	1,760
53.1	29.8	120.5	203.4	3	23	26	10.1	79.6	89.7	293.1	160.4	3,760	340	2,470
439.8	10.5	713.9	1,164.2	9	68	77	516.9	1,376.8	1,893.7	3,057.9	2,091.0	14,990	1,430	17,910
650.4	49.2	149.4	849.0	22	42	64	49.7	976.0	1,025.7	1,874.7	1,688.8	4,585	500	17,140
29.5	79.5	1.5	110.5	9	2	11	5.2	71.9	77.1	187.6	155.6	4,260	310	540
98.0	1.5	3.5	103.0	3	10	13	0.1	509.5	509.6	612.6	609.1	210	15	3,770
1,379.3	239.0	975.5	2,593.8	55	82	137	580.5	1,922.1	2,502.6	5,096.4	3,688.9	30,380	2,600	35,240
1,827.1	200.3	159.4	2,186.8	36	38	74	13.8	1,156.2	1,170.0	3,356.8	3,152.9	6,940	585	43,050
452.9	24.0	76.7	553.6	19	14	33	8.2	945.8	954.0	1,507.6	1,429.9	2,900	270	21,670
44.1	8.6	5.9	58.6	2	3	5	0	35.5	35.5	94.1	87.5	380	35	1,880
609.1	25.9	28.7	663.7	11	8	19	11.1	1,638.9	1,650.0	2,313.7	2,268.5	1,495	130	14,600
6.0	2.1	3.5	11.6	2	1	3	0	57.0	57.0	68.6	64.8	150	15	310
5,647.9	674.8	2,238.5	8,561.2	173	291	464	1,195.9	8,778.4	9,974.3	18,535.5	15,468.1	70,190	6,240	160,340

es rounded to nearest $10,000.

erage, Sewage Treatment, Industrial
Sealing by Basins and States.

ss t (BOD)	Total Population Equivalent (BOD)		Estimated Costs of Waste Treatment Facilities								Estimated Capital Costs of Mine Sealing	
			Existing Municipal		Suggested Municipal		Suggested Industrial		Total Suggested Municipal & Indus.			
Total	Before Treat-ment	As Dis-charged	Capital	Annual	Capital	Annual	Capital	Annual	Capital	Annual	Through 1940	To Complete Program (1) with 1940 Restrictions
2,392.0	4,484.2	4,468.4	1,080	95	67,910	5,595	3,120	1,115	71,030	6,710	0	0
31.2	199.0	110.9	3,800	330	2,310	210	280	75	2,590	285	650	480
678.4	1,598.2	1,514.4	5,460	410	10,020	925	660	230	10,680	1,155	510	1,460
426.3	1,288.5	1,254.7	1,500	115	12,140	985	1,110	470	13,250	1,455	1,820	1,600
164.4	680.1	558.4	4,760	415	4,960	495	1,040	370	6,000	865	60	50
320.6	743.2	492.2	4,550	140	4,870	395	310	140	5,180	535	(2)1,450	(2) 110
	10.2	6.8	190	15	210	20	0	0	210	20	0	0
8.6	57.0	36.0	840	70	620	55	0	0	620	55	(2) -	(2) -
1,400.2	1,716.7	1,675.1	1,300	115	5,000	410	1,270	405	6,270	815	70	120
0.2	24.1	24.1	0	0	530	45	0	0	530	45	40	10
0.4	55.4	53.3	70	10	1,240	110	0	0	1,240	110	70	240
425.9	838.5	251.4	12,890	1,090	930	90	370	90	1,300	180	100	40
65.7	170.4	149.1	530	55	530	50	50	10	580	60	0	0
3.3	28.5	18.9	290	30	700	70	10	0	710	70	0	0
401.5	952.0	482.7	9,380	745	3,680	320	1,180	340	4,860	660	0	0
131.4	236.7	150.4	1,370	155	1,130	100	360	60	1,490	160	60	130
98.9	119.2	105.3	670	80	210	25	250	45	460	70	0	0
3.8	48.8	33.8	450	55	780	80	0	0	780	80	80	310
1,772.0	2,391.7	1,818.9	16,650	1,600	12,830	1,195	1,690	470	14,520	1,655	240	80
258.5	495.8	430.7	1,660	165	6,870	515	270	50	7,140	565	200	780
1,306.0	1,897.3	1,832.6	2,750	250	22,870	1,640	1,610	395	24,480	2,035	20	100
9,974.3	18,535.5	15,[illegible]8.1	70,190	6,240	160,340	13,320	13,580	4,265	173,920	17,585	5,370	5,510
9.4	72.4	70.7	140	10	1,760	150	10	0	1,770	150	0	0
89.7	293.1	160.4	3,760	340	2,470	230	20	5	2,490	235	0	0
1,893.7	3,057.9	2,091.0	14,990	1,430	17,910	1,515	1,830	515	19,740	2,030	270	80
1,025.7	1,874.7	1,688.8	4,585	500	17,140	1,290	1,010	230	18,150	1,520	340	1,200
77.1	137.6	155.6	4,260	310	540	55	90	30	640	85	0	0
509.6	612.6	609.1	210	15	3,770	290	640	105	4,410	395	0	0
2,502.6	5,096.4	3,688.9	30,380	2,600	35,240	3,205	3,440	840	38,680	4,045	1,940	400
1,170.0	3,356.8	3,152.9	6,940	585	43,050	3,710	2,620	1,245	45,670	4,955	1,490	3,100
954.0	1,507.6	1,429.9	2,900	270	21,670	1,475	1,090	305	22,760	1,780	110	420
35.5	94.1	87.5	380	35	1,880	170	160	85	2,040	255	0	150
1,650.0	2,313.7	2,268.5	1,495	130	14,600	1,200	2,570	875	17,160	2,075	1,210	160
57.0	68.6	64.8	150	15	310	30	100	30	410	60	10	0
9,974.3	18,535.5	15,468.1	70,190	6,240	160,340	13,320	13,580	4,265	173,920	17,585	5,370	5,510

(1) Areas connected to active ventilation systems and areas where costs exceed $10.00 per ton per year not included.
(2) Hocking plus Muskingum costs given under Muskingum.

INTRODUCTION

Authorization

The investigation of pollution in the Ohio River Basin has been made in compliance with Section 5, River and Harbor Act, approved August 26, 1937, which reads in part as follows:

> "Sec. 5. That the Secretary of War is hereby authorized and directed to cause a survey to be made of the Ohio River and its tributaries to ascertain what pollutive substances are being deposited, directly or indirectly, therein and the sources and extent of such deposits, and with a view to determining the most feasible method of correcting and eliminating the pollution of these streams.
>
> "The Survey herein authorized shall include comprehensive investigations and studies of the various problems relating to stream pollution and its prevention and abatement. In making these investigations and studies, and in the development and formulation of corrective plans, the Secretary of War may, with the approval of the Secretary of the Treasury, secure the co-operation and assistance of the Public Health Service, and may allot funds from the appropriation hereinafter designated to pay for such co-operation and assistance. The Survey shall be completed as soon as practicable after passage of this Act, and the Secretary of War shall report the results thereof to the Congress, together with such recommendations for remedial legislation as he deems advisable."

Organization

In approving this section of the Act, the President advised the Secretary of War that he desired the appointment of a committee to supervise the Survey, the Committee to be composed of a representative of the Army Engineer Corps, the Public Health Service, and a non-Government expert to be selected by the other two members. Pursuant to this recommendation, the Survey has been made under the general supervision of a committee composed of Brigadier General Max C. Tyler, later succeeded by Brigadier General T. M. Robins, representing the Corps of Engineers, U. S. Army; Senior Sanitary Engineer R. E.

Tarbett, representing the Public Health Service; and Dr. Abel Wolman, Johns Hopkins University, selected as the non-Government expert.

Under this Committee, data on sources of pollution and laboratory data have been collected by the U. S. Public Health Service and hydrometric data have been collected by the U. S. Engineer Department.

The attached organization chart gives in detail the plan of operation for the conduct of the survey.

Report

In presenting and discussing the data collected, this general section is followed by summaries covering the main Ohio River, minor tributaries and the individual major tributaries. Each summary follows a generally uniform pattern. A number of supplements of general interest on various phases of the work will follow with the report or later.

Survey Methods

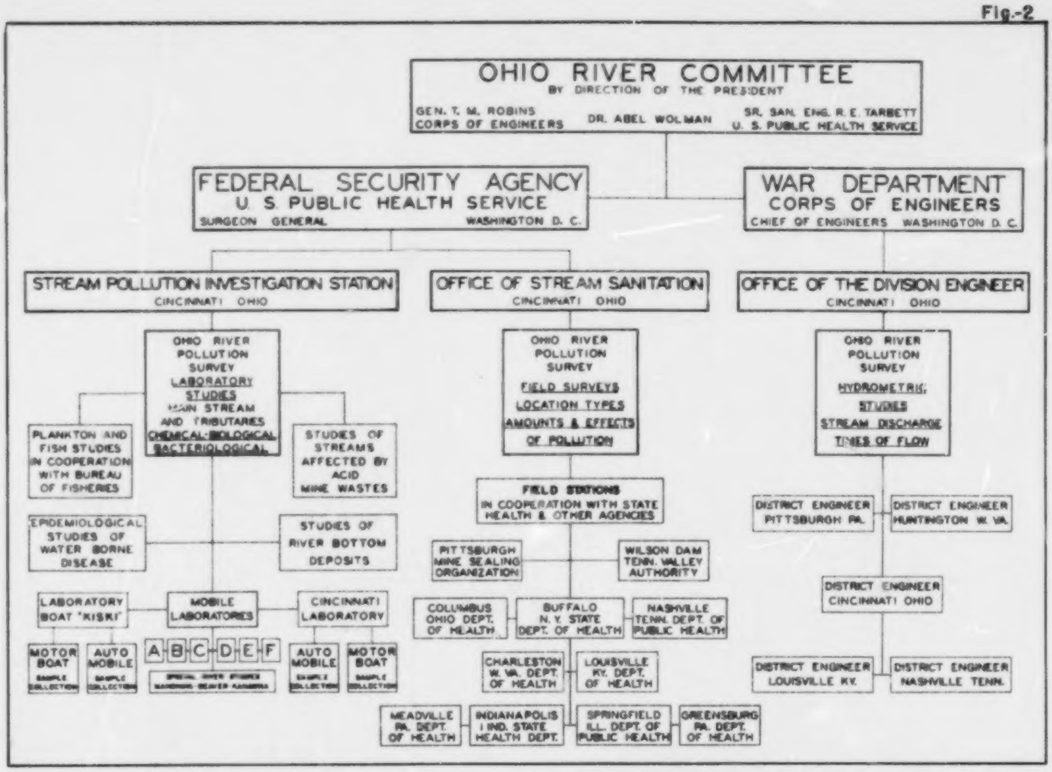
The data collected by the Ohio River Pollution Survey comprises three principal types of information:

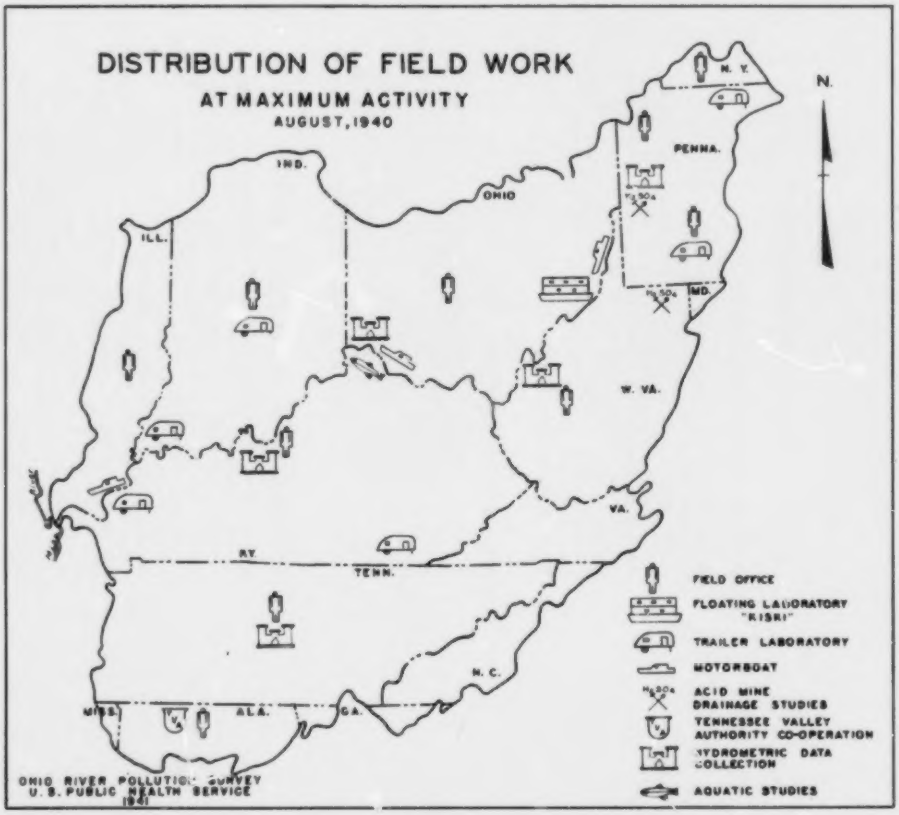
1. Data on sources of pollution
2. Laboratory data
3. Hydrometric data.

Data on sources of pollution were obtained by engineers working at, and out of, eleven field stations maintained for varying periods of time in the offices of State health departments and of the Tennessee Valley Authority. Surveys were made of some 3,700 municipalities and 1,800 industrial plants.

Special studies of industrial wastes were made in cooperation with the cities of Cincinnati and Louisville, the State of West Virginia and the Tennessee Valley Authority. These studies were of value, not only in showing the character and amount of wastes discharged at the plants studied, but also in estimating the effect of wastes from similar plants elsewhere in the basin where less detailed information was available. A special field unit surveyed the acid mine drainage problem and determined the amount and distribution of this type of waste.

Fig.-2


OHIO RIVER COMMITTEE
BY DIRECTION OF THE PRESIDENT
GEN. T. M. ROBINS
CORPS OF ENGINEERS
DR. ABEL WOLMAN
SR. SAN. ENG. R. E. TARBETT
U. S. PUBLIC HEALTH SERVICE
FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
SURGEON GENERAL
WASHINGTON D. C.
WAR DEPARTMENT
CORPS OF ENGINEERS
CHIEF OF ENGINEERS
WASHINGTON D. C.
STREAM POLLUTION INVESTIGATION STATION
CINCINNATI OHIO
OFFICE OF STREAM SANITATION
CINCINNATI OHIO
OFFICE OF THE DIVISION ENGINEER
CINCINNATI OHIO
OHIO RIVER POLLUTION SURVEY
LABORATORY STUDIES
MAIN STREAM AND TRIBUTARIES
CHEMICAL-BIOLOGICAL
BACTERIOLOGICAL
PLANKTON AND FISH STUDIES IN COOPERATION WITH BUREAU OF FISHERIES
STUDIES OF STREAMS AFFECTED BY ACID MINE WASTES
EPIDEMIOLOGICAL STUDIES OF WATER BORNE DISEASE
STUDIES OF RIVER BOTTOM DEPOSITS
LABORATORY BOAT "KISKI"
MOBILE LABORATORIES
CINCINNATI LABORATORY
MOTOR BOAT
SAMPLE COLLECTION
AUTO MOBILE
SAMPLE COLLECTION
A
B
C
D
E
F
AUTO MOBILE
SAMPLE COLLECTION
MOTOR BOAT
SAMPLE COLLECTION
OHIO RIVER POLLUTION SURVEY
FIELD SURVEYS
LOCATION TYPES
AMOUNTS & EFFECTS OF POLLUTION
FIELD STATIONS
IN COOPERATION WITH STATE HEALTH & OTHER AGENCIES
PITTSBURGH MINE SEALING ORGANIZATION
WILSON DAM TENN. VALLEY AUTHORITY
COLUMBUS OHIO DEPT. OF HEALTH
BUFFALO N. Y. STATE DEPT. OF HEALTH
NASHVILLE TENN. DEPT. OF PUBLIC HEALTH
CHARLESTON W. VA. DEPT. OF HEALTH
LOUISVILLE KY. DEPT. OF HEALTH
MEADVILLE PA. DEPT. OF HEALTH
INDIANAPOLIS IND. STATE HEALTH DEPT.
SPRINGFIELD ILL. DEPT. OF PUBLIC HEALTH
GREENSBURG PA. DEPT. OF HEALTH
OHIO RIVER POLLUTION SURVEY
HYDROMETRIC STUDIES
STREAM DISCHARGE
TIMES OF FLOW
DISTRICT ENGINEER PITTSBURGH PA.
DISTRICT ENGINEER HUNTINGTON W. VA.
DISTRICT ENGINEER CINCINNATI OHIO
DISTRICT ENGINEER LOUISVILLE KY.
DISTRICT ENGINEER NASHVILLE TENN.


DISTRIBUTION OF FIELD WORK
AT MAXIMUM ACTIVITY
AUGUST, 1940

N.
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FIELD OFFICE
FLOATING LABORATORY "KISKI"
TRAILER LABORATORY
MOTORBOAT
ACID MINE DRAINAGE STUDIES
TENNESSEE VALLEY AUTHORITY CO-OPERATION
HYDROMETRIC DATA COLLECTION
AQUATIC STUDIES

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

OHIO RIVER POLLUTION SURVEY

(Total Personnel - 95).

Technical Staff

Office of Stream Sanitation (38)

Cincinnati Headquarters (15)

Crohurst, H. R., Senior Sanitary Engineer
Tisdale, Ellis S., Sanitary Engineer (R)
LeBosquet, M. Jr., Senior Public Health Engineer
Hollis, Mark D., Passed Assistant Sanitary Engineer
Woodward, Richard L., Associate Public Health Engineer
Weibel, Samuel R., Associate Public Health Engineer
Eiffert, William T., Assistant Public Health Engineer
Palange, Ralph C., Assistant Sanitary Engineer (R)
Draftsmen (2)
Stenographers and Clerks (5)

Field Engineers, First Year (8)

McCallum, Gordon E., Associate Public Health Engineer
Poston, Richard F., Associate Public Health Engineer
Keatley, Charles R., Associate Public Health Engineer
Yaffe, Charles D., Assistant Public Health Engineer
Freeman, Archie B., Assistant Public Health Engineer
Reed, George D., Assistant Public Health Engineer
Solander, Arvo A., Assistant Public Health Engineer
Bourne, H. Gardner, Jr., Assistant Chemical Engineer

Additional Field Engineers, Second Year (15)

Haney, Paul D., Assistant Sanitary Engineer (R)
Seufer, Paul E., Assistant Sanitary Engineer (R)
Spencer, Charles C., Assistant Sanitary Engineer (R)
Pearl, Emanuel H., Assistant Public Health Engineer
Flanagan, Joseph E., Jr., Assistant Sanitary Engineer (R)
Johnson, Ralph J., Assistant Sanitary Engineer (R)
Porges, Ralph, Assistant Sanitary Engineer (R)
McKinstry, Edward N., Assistant Public Health Engineer
Murray, William C., Assistant Public Health Engineer
Clark, Sterling N., Assistant Sanitary Engineer (R)
Joseph, Edwin B., Assistant Sanitary Engineer (R)
Okun, Daniel A., Assistant Sanitary Engineer (R)
Raneri, Ray, Assistant Sanitary Engineer (R)
Rostenbach, Royal E., Assistant Chemical Engineer
Terrill, James G., Jr., Assistant Sanitary Engineer (R)

Stream Pollution Investigations Station (57)

Cincinnati Headquarters (20)

Streeter, H. W., Senior Sanitary Engineer
Forsbeck, Filip C., Surgeon*
Wheeler, Ralph C., Surgeon (R)
Brinley, Floyd J., Associate Biologist
Carnahan, Charles T., Public Health Engineer
DeMartini, Frank E., Associate Public Health Engineer
Burns, William E., Junior Bacteriologist
Ettinger, Morris B., Assistant Sanitary Chemist
Katzin, Leonard I., Junior Aquatic Biologist
Chambers, Cecil W., Junior Sanitary Bacteriologist
Draftsman (1)
Statistical Clerks (4)
Laboratory Attendants (4)
Sample Collector (1)
Motorboat Operator (1)

Field Laboratories (37)

Monroe, Stanley G., Associate Public Health Engineer
Levine, Benjamin S., Bacteriologist
Chapman, Charles R., Passed Assistant Sanitary Engineer (R)
Fittro, Louis L., Assistant Sanitary Engineer (R)
Kass, Edwin A., Assistant Sanitary Engineer (R)
McNair, John C., Assistant Chemical Engineer
Walker, William W., Assistant Sanitary Chemist
Cohen, Stuart, Junior Chemist
Megregian, Stephen, Junior Chemist
Middleton, Francis M., Junior Chemist
Norris, Francis I., Junior Chemist
Pettijohn, O. Glenn, Junior Chemist
Snider, Ross A., Junior Chemist
Lucht, Robert A., Junior Chemical Engineer
Laboratory Attendants (9)
Sample Collectors (9)
Shipkeepers (3)
Motorboat Operators (2)

(*) Deceased

Note: Official designations apply to the last day of each person's connection with the Ohio River Pollution Survey

Correlated work included the preparation of "Industrial Waste Guides" containing information on industrial plant processes and practices, the quantities and strength of wastes for representative plants, waste treatment and recovery practices and their effectiveness in reducing pollution; an investigation of pollution abatement laws in the various states, their administration, and effectiveness; a study of the cost of construction and operation of waste treatment plants both for municipal and industrial wastes; a study of damages caused by water pollution; an investigation of soil erosion and its relation to water pollution; studies of population distribution and trends, of the physiography, climate, cultural and economic background of the basin as it might affect future pollution or abatement.

The major part of the laboratory data was obtained by physical, chemical and bacteriological tests on samples of water from some 2,000 points on streams in the Ohio River Basin. The sampling points were located so as to give a representative picture of the quality of the streams of the basin and the effect of waste discharges on water quality. More than 71,000 samples were examined and some 131,000 tests made. Laboratories were located at the U. S. Public Health Service Stream Pollution Investigations Station at Cincinnati, the quarterboat Kiski, loaned by the U. S. Engineer Department and equipped for laboratory work, and at six mobile laboratories in automobile trailers.* The Kiski and the trailer laboratories were moved from place to place as the work required and samples collected and brought to the laboratories by automobile and motorboat.

Laboratory work was begun in 1939 and the area from the mouth of the Kanawha River to the mouth of the Kentucky River was surveyed during that year. The survey, which had originally been planned to continue for three years, was then shortened to two years because of the defense emergency. As a result the data on the upper and lower thirds of the basin are less extensive than was originally planned.

The attached table shows the routine laboratory examinations which were made and a brief explanation of each. Special laboratory tests made from time to time on selected samples have included nitrites, nitrates, acidity to phenolphthalein

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* Public Health Reports, April 11, 1941, - pages 754-760 (Reprint No. 2259).

(hot and cold), total hardness and phenol content.

Recognizing the importance of standard techniques to secure comparable results from the several laboratories, systematic and thorough instruction in standard methods of water analysis, covering a period of from four to six weeks, was given to all laboratory personnel, at the Cincinnati laboratory, prior to detail in the field. Frequent checks were made to observe methods and results and to correct any inconsistencies in technique. Memoranda to personnel covering laboratory methods are included in a supplement to this report.

In addition to the routine stream sampling program, a number of special investigations were made. These include an investigation of water quality requirements for various water uses; an epidemiological study of outbreaks of intestinal diseases suspected of being water-borne; a biological study of the effects of pollution on plankton and higher forms of aquatic life, notably fish; a controlled study to measure the effect of complete and partial mine sealing on streams; studies of tastes and odors in water supplies along the lower Kanawha, the Mahoning and Beaver Rivers, in co-operation with the State health departments of Ohio, Pennsylvania and West Virginia; and studies of mud deposits behind the navigation dams on the main Ohio River.

All hydrometric data were obtained by the Division Engineer's Office, U. S. Engineer Department, Ohio River Division, with the assistance of the five District Engineer Offices in the basin. In addition to the operation of the regular stream gaging stations, the work included the measurement or estimation of stream flows at each sampling station on the days when samples were collected; compilation of monthly flows during the summer months for the entire period of record at selected stations and preparation of frequency curves of low flows; studies of water velocities and times of flow in the main Ohio River and certain tributaries; and studies of possible modification of flow conditions by proposed flood-control reservoirs.

Acknowledgments

The various state health departments of the Ohio River Basin have rendered invaluable help to this survey by making available the results of their years of experience in pollution abatement work, by furnishing office space to field engineers, and by assisting in many other ways. The State of

Table 2 Ohio Basin - Significance of Various Physical, Chemical and Bacteriological Tests used in Ohio River Pollution Survey.

Test	Explanation
	Physical and Chemical Tests
1. Temperature	Governs the solubility of oxygen and influences rates of purification.
2. Turbidity	An index of the density of silt or other suspended matter carried by the stream.
3. pH	or Hydrogen-ion concentration, indicates the relative acidity or alkalinity of a water.
4. Alkalinity	Represents the content of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates.
5. Total and volatile suspended matter *	Represents the concentration of suspended matter, in terms of dry solids, and is a rough index of the organic waste material present.
6. Dissolved Oxygen	Essential to natural purification of streams and the maintenance of aquatic life, is drawn upon to support biochemical oxidation of organic waste and is replaced by absorption from the atmosphere and the photosynthetic action of some water plants including algae. A deficiency in dissolved oxygen below the saturation level indicates the presence of polluting organic substances which are absorbing oxygen from the stream water. The degree of this deficiency is a measure of the deoxygenating effect of the polluting matter and hence an index of the degree of pollution in a particular stream zone.
7. Five-day biochemical oxygen demand at 20°C. (B.O.D.)	Indicates the amount of dissolved oxygen which may be expected to be absorbed from the stream water in five days at 20°C. to support the biochemical oxidation of the organic pollution carried by the stream at the point of sampling.
	Bacteriological Tests
8. Total count on agar in 24 hours at 37°C. *	Considered in conjunction with the coliform bacteria the plate count is of value both as an indication of pollution and as a rough measure of natural stream purification.
9. Coliform bacteria (determined by standard fermentation tube test at 37°C.)	Expressed as "most probable number"(M.P.N.). This test is the most delicate and specific test for pollution by sewage as it shows the approximate density of a group of bacteria which are always present in large numbers in sewage and are relatively few in number in other stream pollutants. Coliform bacteria are normal inhabitants of the intestines of warm blooded animals and are discharged in large numbers in human feces, which constitute the principal source of these bacteria in sewage.
10. Coliform bacteria-(determined by direct plate count on brilliant green lactose bile at 37°C.)	Utilizes the plate count method, rather than the fermentation tube method, for the determination of coliform bacteria using a culture medium selective for this type of organism.

* Discontinued as a routine test at the end of 1939.

Tennessee, in addition, furnished results of stream sampling programs. The Health and Safety Section of the Tennessee Valley Authority has aided similarly by furnishing office space, and the results of its investigations of the streams and waste discharges in the Tennessee River Basin. Municipal officials, water and sewage treatment plant operators, and industrial officials have aided by furnishing data on waste discharges and plant operation. In a number of instances municipal officials have furnished water and electric power for trailer laboratory units without charge. The cities of Cincinnati and Louisville have assisted by making available the results of consulting engineers' studies of their waste treatment problems. The City of Dayton, Ohio, furnished results of stream sampling conducted by its sewage treatment plant laboratory. Among the Federal Agencies that have assisted are the Fish and Wildlife Service, which made physiological examinations of fish specimens, the U. S. Geological Survey, which furnished maps and advance data on stream flow, the Bureau of the Census, which furnished advance data on population, the U. S. Bureau of Mines, which aided in the study of acid mine drainage, the Soil Conservation Service, which furnished data on the extent and severity of soil erosion, and the National Resources Planning Board, which made available the results of its studies of the Ohio River Basin. In the preparation and criticism of "Industrial Waste Guides," assistance has been received from State, Federal, municipal and industrial officials throughout the country and from consulting engineers, equipment manufacturers, trade associations, universities and technical schools.

DESCRIPTION

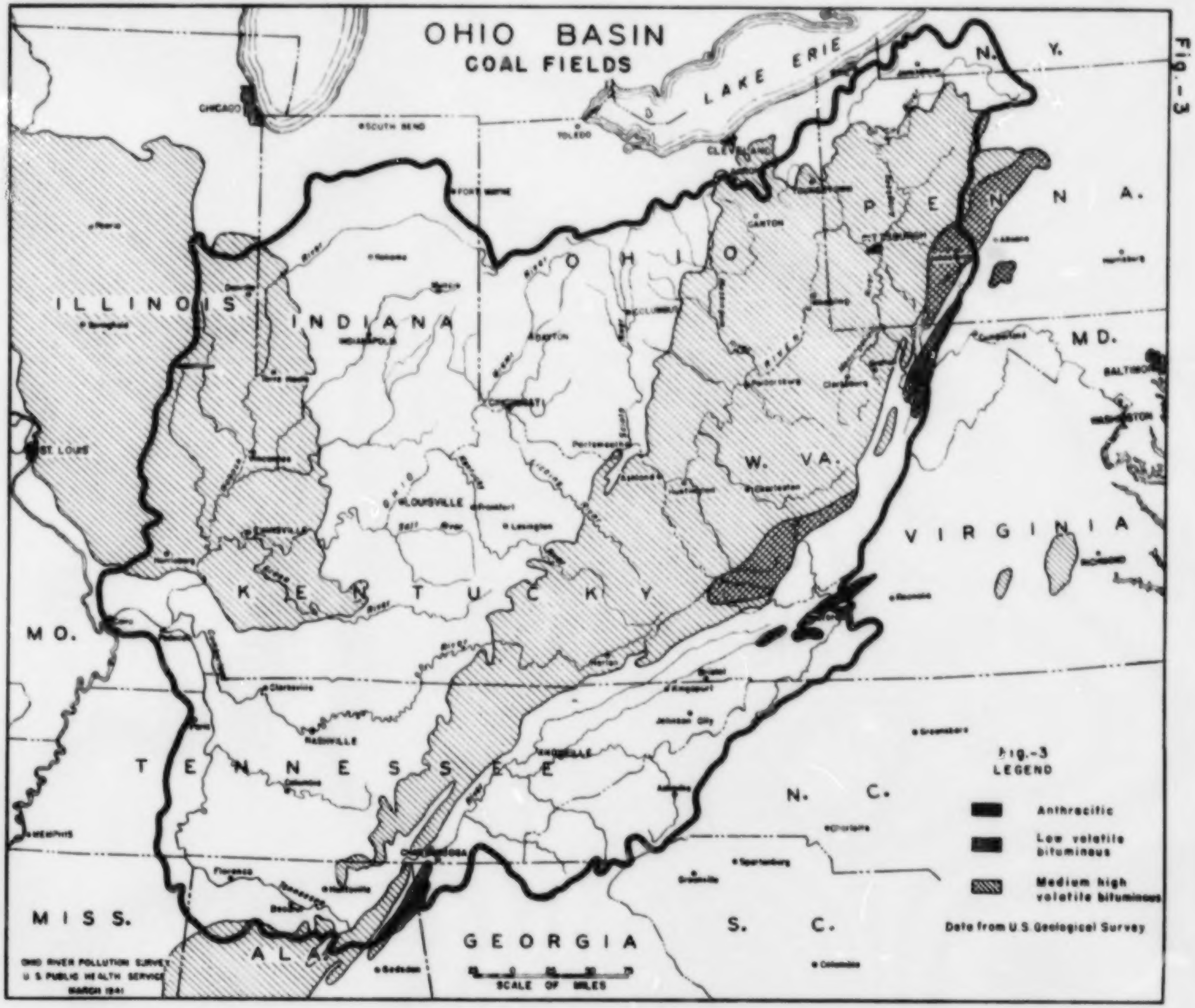
The Ohio River Basin (Fig. 1) includes 203,900 square miles, about seven percent of the continental United States. It extends into 14 states. The river originates at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh and flows generally southwest for a distance of 981 miles to its confluence with the Mississippi River at Cairo, Illinois. It is the second largest tributary of the Mississippi but the largest contributor to its flow.

Besides the Allegheny and Monongahela Rivers, the larger tributaries are the Beaver, Muskingum, Hocking, Scioto, Little Miami, Miami and Wabash Rivers entering from the north, and the Little Kanawha, Kanawha, Guyandot, Big Sandy, Licking, Kentucky, Salt, Green, Cumberland and Tennessee Rivers entering from the south. The various tributary basins are outlined on Figure 1 and their drainage areas are shown in Table 1.

Topography - Three major physical divisions characterize the Ohio Basin, the Appalachian Highlands in the east, the Interior Plateau in the southwest and the Interior Plains in the northwest. The Appalachian Highlands include practically all of the area draining to the Ohio above the Scioto River as well as the headwaters of the Licking, Kentucky and Cumberland Rivers and the upper half of the Tennessee River. The land is generally hilly or mountainous with steep slopes and narrow stream valleys. The Interior Plateau includes the area south of the Ohio River and west of the mountains and small parts of southern Ohio, Indiana and Illinois. The hills in this section are lower and less steep than in the Highlands and the stream valleys generally wider. The well-known Bluegrass section of Kentucky and the Nashville Basin in Tennessee are the most highly developed parts of the Interior Plateau. The Interior Plains include most of the land north of the Ohio River and west of the Highlands. The land is level or gently rolling. Practically all of this section has been covered by glaciers and most of the land is fertile and well suited to agriculture. It is the principal farming section of the Ohio Basin and constitutes the eastern third of the "Corn Belt."

Geology - Limestones and shales are the most common bedrocks of the basin. The principal mineral resource is coal which underlies much of the highland section (see Figure 3). Coal is also mined in western Indiana, Kentucky and in Illinois. The Ohio Basin accounts for about eighty percent of the total national coal production. Petroleum and natural gas has been

Fig.-3



OHIO BASIN
COAL FIELDS

LAKE ERIE
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
FORT WAYNE
CANTON
PITTSBURGH
COLUMBUS
CINCINNATI
ST. LOUIS
LOUISVILLE
NASHVILLE
KNOXVILLE
CHATTANOOGA
BALTIMORE
WASHINGTON
Salt River
Lexington
Johnson City
Kingsport
Florence
Decatur
Memphis
Gadsden
Greensboro
Spartanburg
Greenville
Columbia
Charlotte
Roanoke
Portsmouth
Charleston
Huntington
Clarksburg
Parkersburg
Cumberland
Harrisburg
Clarksville
Columbia
ILLINOIS
INDIANA
OHIO
PENNA.
N. Y.
MD.
W. VA.
VIRGINIA
KENTUCKY
TENNESSEE
MO.
MISS.
ALA.
GEORGIA
N. C.
S. C.
SCALE OF MILES

Fig.-3
LEGEND

■ Anthracitic
▩ Low volatile bituminous
▨ Medium high volatile bituminous

Data from U.S. Geological Survey

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
MARCH 1941

Fig. 4

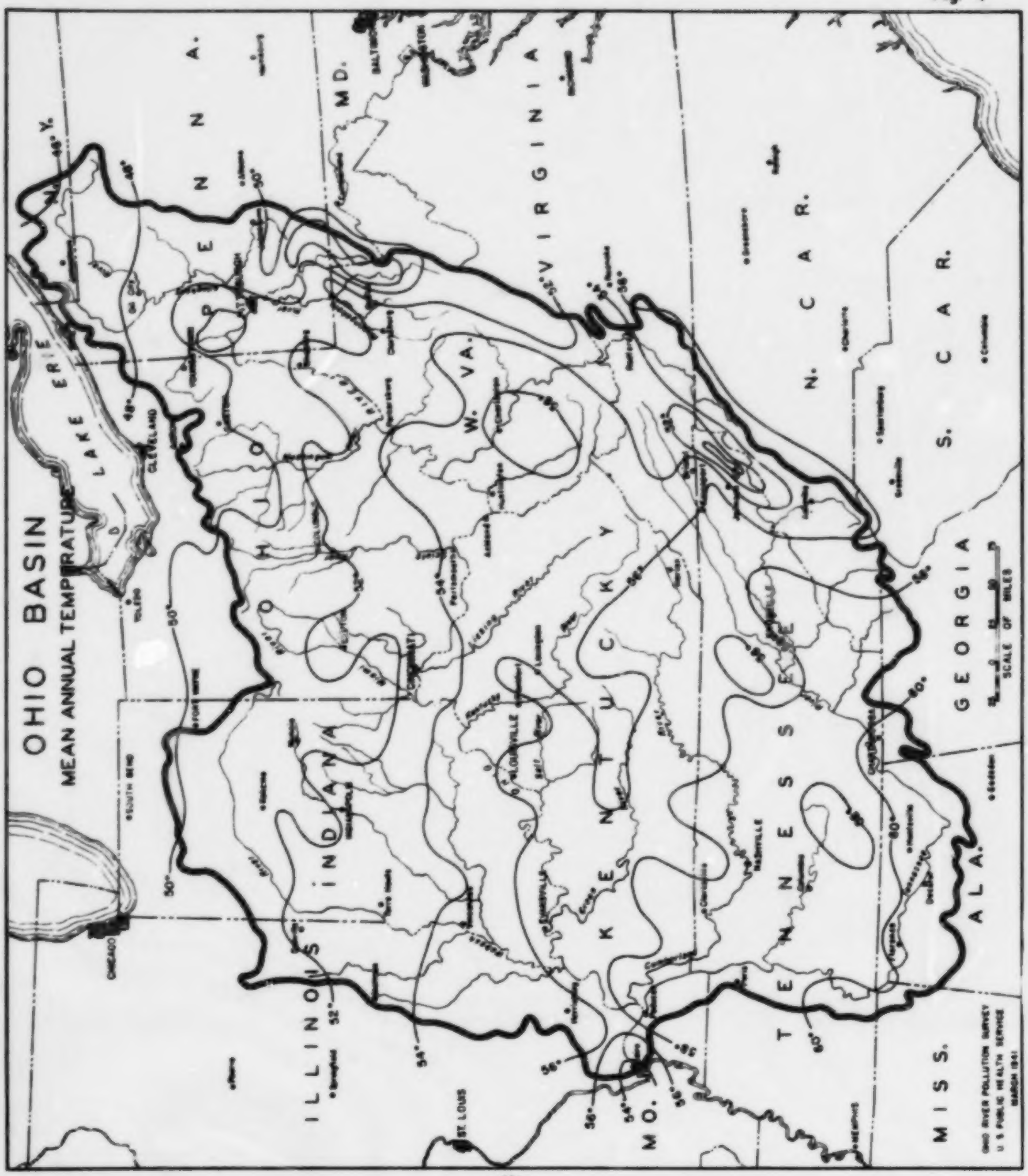
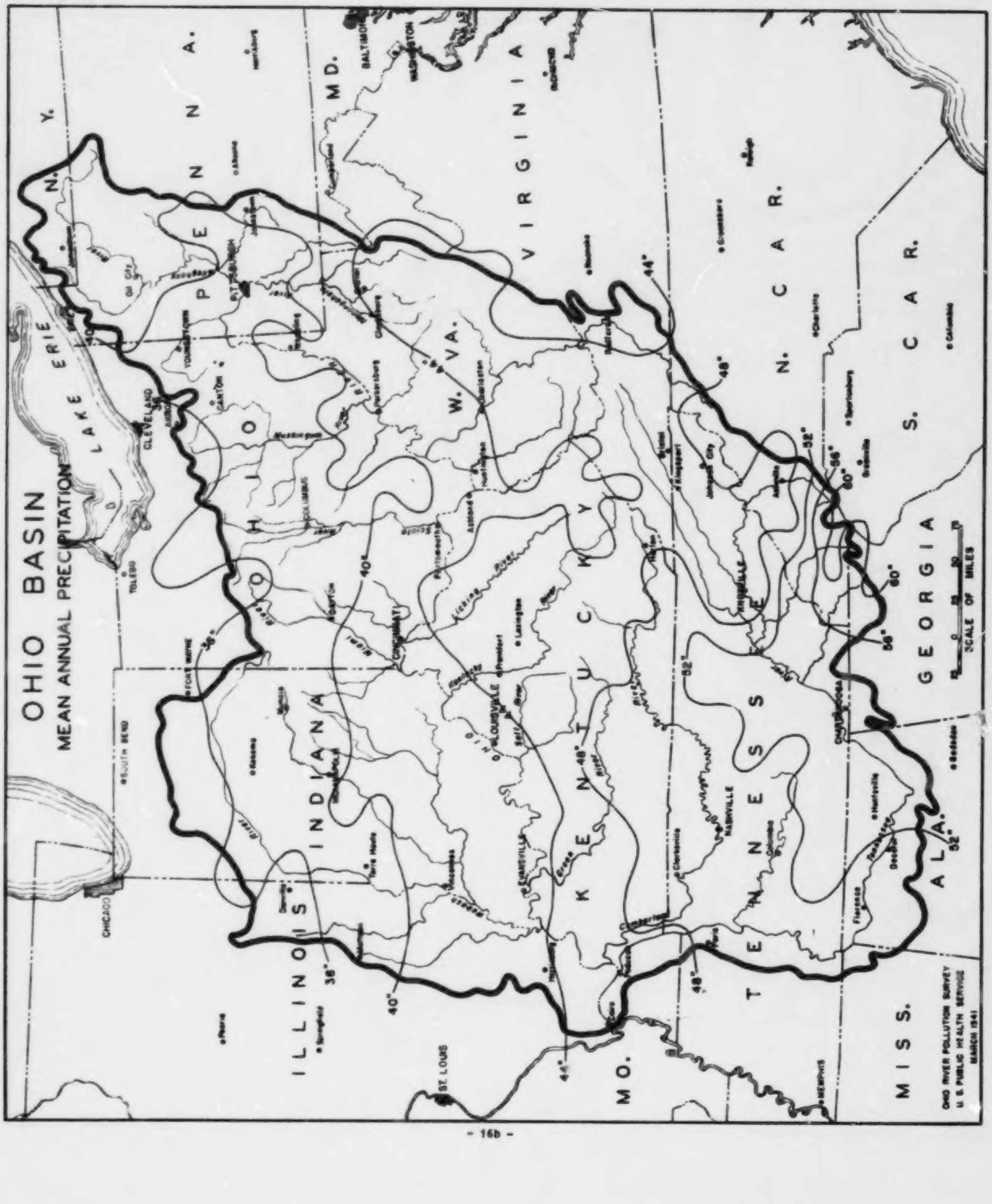

OHIO BASIN
MEAN ANNUAL TEMPERATURE
LAKE ERIE
OHIO
INDIANA
ILLINOIS
PENNA.
N.Y.
MD.
W. VA.
VIRGINIA
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
MO.
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
BALTIMORE
LOUISVILLE
NASHVILLE
ST. LOUIS
50°
52°
54°
56°
58°
60°
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
U S PUBLIC HEALTH SERVICE
MARCH 1941

Fig. 5



OHIO BASIN
MEAN ANNUAL PRECIPITATION

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
MARCH 1941

LAKE ERIE
N. Y.
P E N N A.
MD.
V I R G I N I A
W. VA.
O H I O
I N D I A N A
I L L I N O I S
K E N T U C K Y
T E N N E S S E E
N. C A R.
S. C A R.
G E O R G I A
A L A.
MISS.
MO.
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
AKRON
CANTON
YOUNGSTOWN
PITTSBURGH
Oil City
BALTIMORE
WASHINGTON
COLUMBUS
FORT WAYNE
CINCINNATI
LOUISVILLE
Frankfort
Lexington
Terre Haute
EVANSVILLE
NASHVILLE
KNOXVILLE
CHATTANOOGA
ST. LOUIS
MEMPHIS
Cairo
Charlotte
Columbia
Birmingham
Lake
Ohio
Cumberland
Kentucky
Muskingum
Scioto
Miami
Wabash
Green
Licking River
36°
40°
44°
48°
52°
56°
60°
SCALE OF MILES
25 0 25 50 75

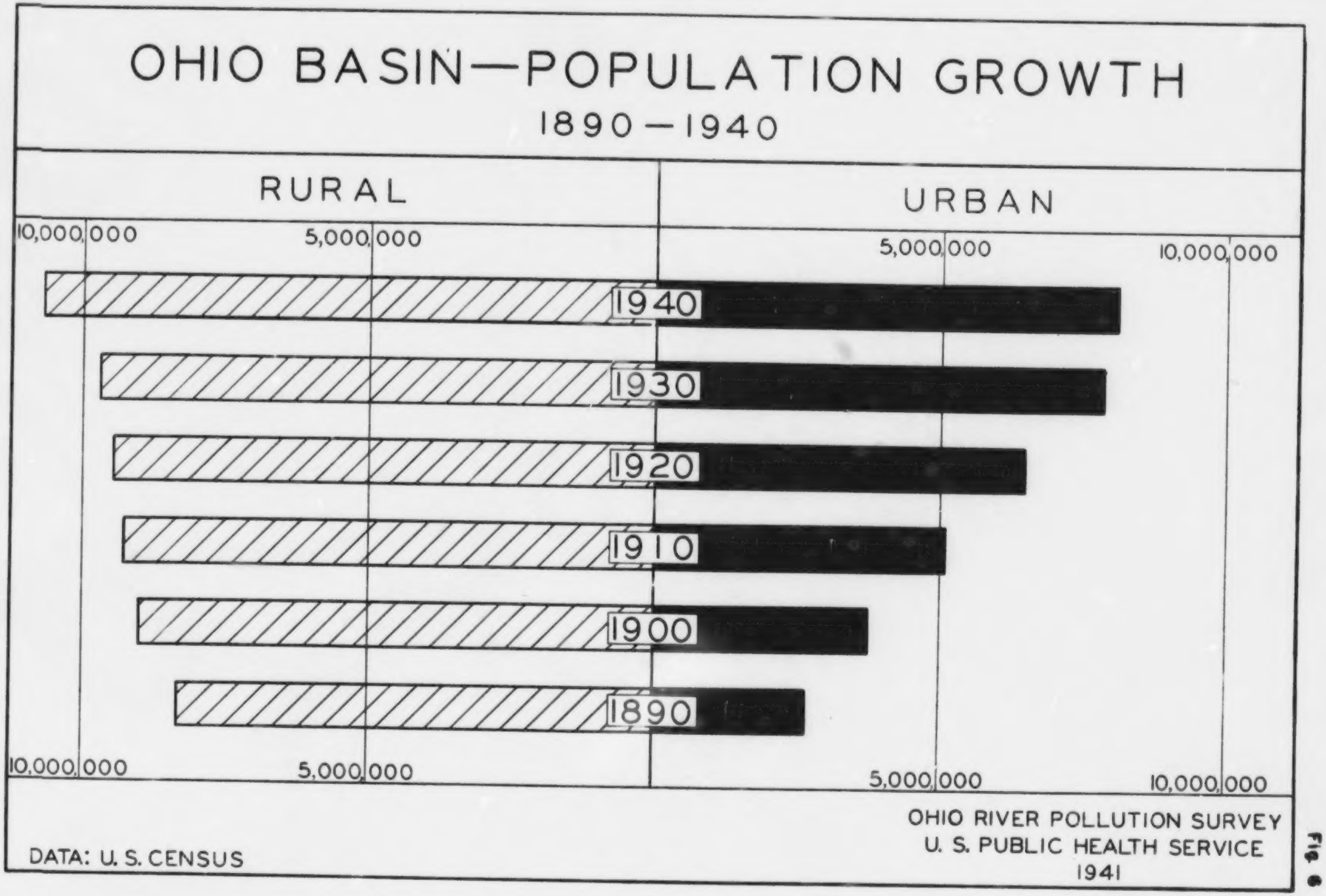
developed in the Appalachian fields of New York, Pennsylvania, Ohio, West Virginia, Kentucky and Tennessee, in western Ohio, northeastern and southwestern Indiana; and in central and southern Illinois. In recent years the development of the southern Illinois oil field has made that state the second largest oil producing state in the country. Other minerals of commercial importance include building stone, phosphate rock, various types of clay, sand, gravel, rock asphalt and fluor spar.

Climate - The climate of the basin is temperate and continental and well suited to various types of agriculture. Mean annual temperatures vary from 40°F. in the north to over 60°F. in the south (see Fig. 4). Extremes of -35°F. and over 100°F. have been recorded. Mean annual rainfall varies from about 36 inches in the north to 60 inches in the southeast (see Fig. 5).

Run-off - On an average about one-third to one-half of the rainfall appears as stream flow but this is subject to extreme variations. The flow of the Ohio River at the mouth has varied from as little as 20,000 c.f.s. to as much as 1,850,000 c.f.s., with the average being about 250,000 c.f.s. The winter and early spring months are usually the period of high run-off. Major Ohio River floods have almost always occurred between January and the middle of April. The streams usually fall with the advent of the growing season. May and June are usually months of moderately high flow and the low-flow season includes the months from July through October or November. The minimum flows usually occur in September or October.

The ten years from 1930 to 1939 included a number of notably dry years. The summer and fall months of 1930, 1932, 1934, 1936 and 1939 were among the driest in various parts of the basin. During 1930 the drought was particularly severe and general. The Ohio River and most of its tributaries experienced their lowest flows of record during the late summer and early fall months of 1930. The drought continued throughout much of the winter and into the early months of 1931.

Population - The population of the Ohio Basin in 1940 was approximately 18,800,000, of which about 44 percent was classified as urban and 56 percent as rural. This represents a population density of more than twice the national average. The basin is somewhat less urbanized than the nation as a whole where about 56 percent of the population is urban. Table 1



OHIO BASIN—POPULATION GROWTH
1890—1940

DATA: U. S. CENSUS

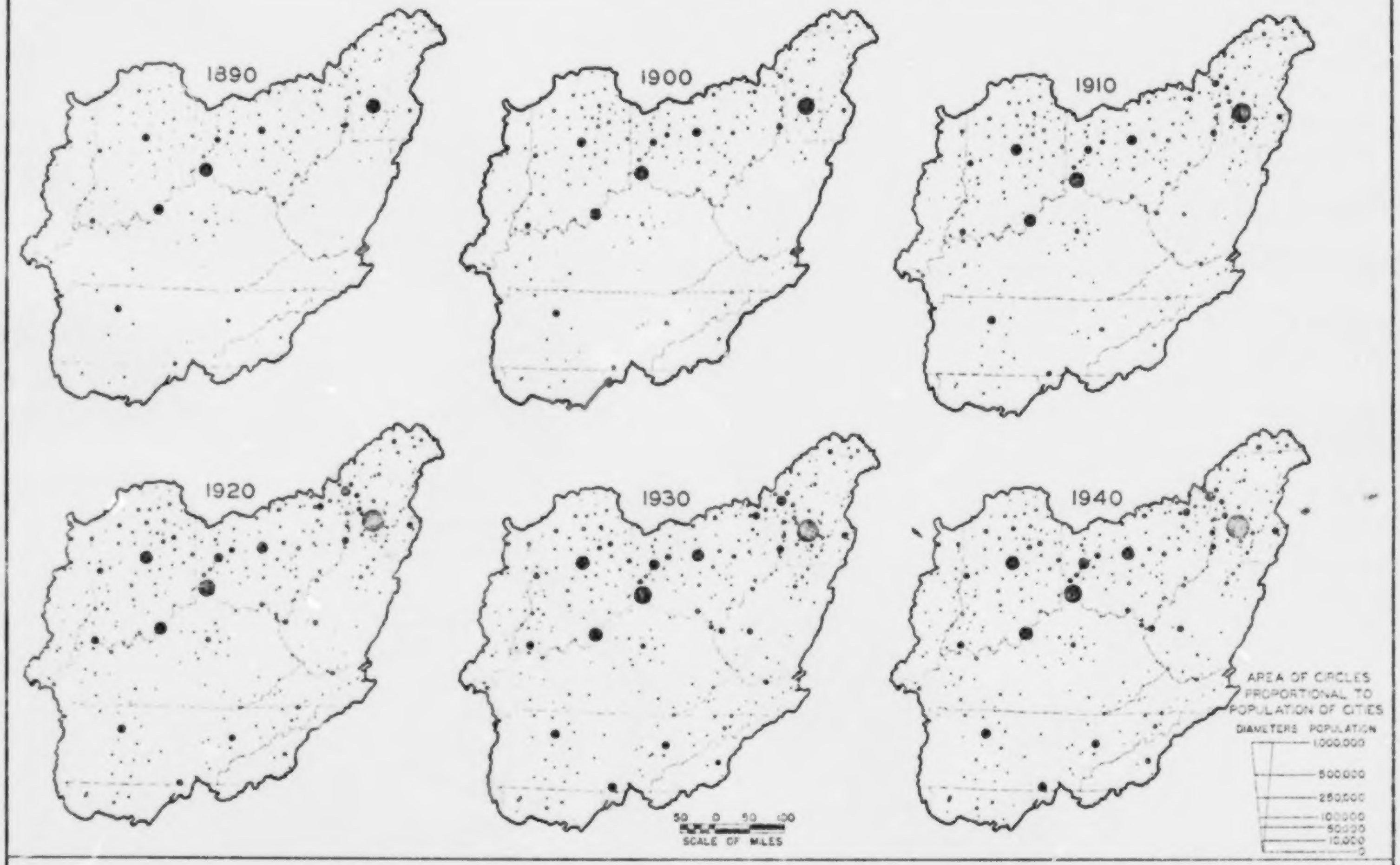
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig. 6

FIG.-7

OHIO BASIN—URBAN POPULATION 1890-1940

INCORPORATED PLACES OF 2500 OR MORE


1890
1900
1910
1920
1930
1940
50 0 50 100
SCALE OF MILES
AREA OF CIRCLES PROPORTIONAL TO POPULATION OF CITIES
DIAMETERS POPULATION
1,000,000
500,000
250,000
100,000
50,000
10,000
0

DATA: U. S. CENSUS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

15-A

shows the distribution of population by basins and states. Figure 6 shows the increase in population for the years 1890 to 1940, and Figure 7 shows the distribution of urban population for the same years. The northern and eastern parts of the basin are more densely populated and more highly urbanized than the southern and western parts but in recent years the rate of growth has been more rapid in the southern states than in the north.

Navigation - The Ohio River has been canalized, 46 locks and dams now providing a nine-foot channel at low water. Most of these dams are movable, that is, when not needed during periods of high flow they are dropped to the bottom of the river and boats can pass over them without going through the locks. Four of the dams are fixed and boats must use the locks at all times. These four are the Emsworth, Dashield's and Montgomery Island Dams at the upper end of the river near Pittsburgh and the Gallipolis Dam below the mouth of the Kanawha River.

In addition to the main stream most of the larger tributaries have been canalized for varying distances. Almost 2,000 miles of the Allegheny, Monongahela, Muskingum, Little Kanawha, Kanawha, Big Sandy and its tributaries (Tug Fork and Levisa Fork), Kentucky, Green and its tributaries (Barren and Rough Rivers), Cumberland and Tennessee have been improved for navigation.

The facilities on most of these streams are not extensively used but the Monongahela River is one of the most heavily traveled inland waterways in the world and the Allegheny also carries a large amount of freight in the vicinity of Pittsburgh.

Flood Control - The acute need for flood control on the Ohio River and its tributaries was brought to national attention by the disastrous floods of 1936 and 1937. Prior to that time a number of flood-control projects had been initiated locally, notably those of the Miami and Muskingum Conservancy Districts. The Tennessee Valley Authority and the U. S. Engineer Department also had constructed some reservoirs and other works for flood control. Following the floods of 1936 and 1937 the Congress authorized the construction of a comprehensive system of reservoirs on Ohio River tributaries and numerous levees and walls for flood protection. Figure 8 shows the location of existing flood-control reservoirs, those under construction and projects being studied. Because major floods usually occur during the winter and early spring, it may be possible to use some of the storage capacity at a number of these reservoirs for low-flow regulation during the summer and early fall months.

Hydroelectric power - The largest hydroelectric developments in the basin are on the Tennessee River and its tributaries. The Kanawha and New Rivers also are the sites of several power projects. Others are on the Ohio River at Louisville, the Clarion River, a tributary of the Allegheny, the Youghiogheny and Cheat Rivers, tributaries of the Monongahela, Dix River, a tributary of the Kentucky and the Tippecanoe River and East Fork of White River, tributaries of the Wabash. Two large flood-control reservoirs with excellent power possibilities are under construction at present. These are the Bluestone Reservoir on the New River and the Wolf Creek Reservoir on the Cumberland.

The power facilities of the Tennessee Valley Authority are being expanded rapidly and a number of new projects are under construction. The installed capacity of the entire system is approaching 1,500,000 kilowatts.

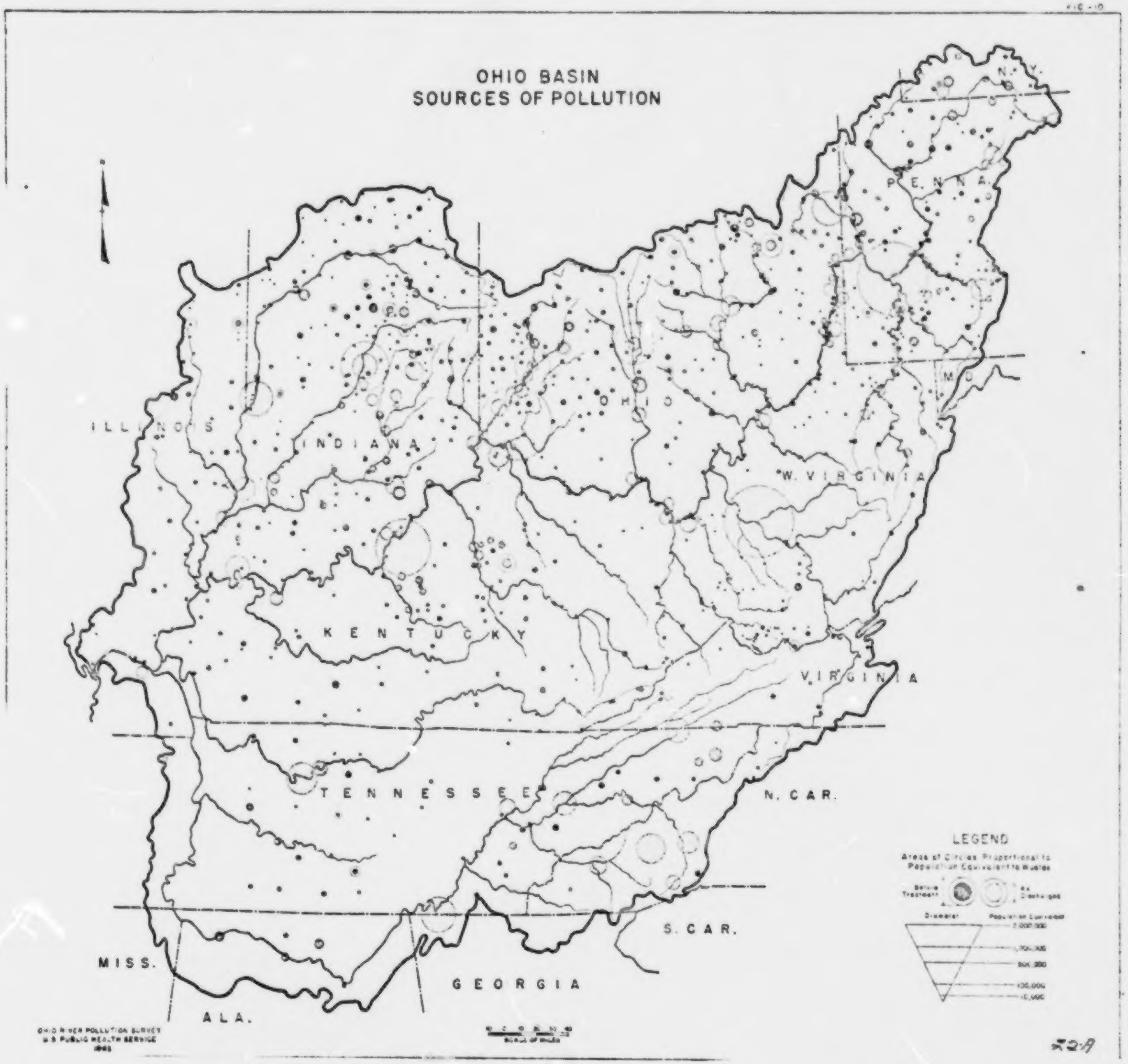
Low-flow Control - Pymatuning Reservoir on the Shenango River and Milton Reservoir on the Mahoning River, both tributaries of the Beaver, are the outstanding examples of projects built primarily for low-flow control. Both of these streams are used as sources of industrial water supply by the steel industry and the reservoirs were built to relieve the acute shortage which occurred almost every summer. The Tygart River Reservoir, a multiple-purpose project on a tributary of the Monongahela, was built by the U. S. Engineer Department to ensure an adequate flow for the maintenance of navigation on the Monongahela in addition to providing flood control.

Recreation - An increasing demand for water recreational facilities has been apparent in recent years. The extensive use of the recently completed reservoirs of the Tennessee Valley Authority and the Muskingum Conservancy District, as well as other bodies of water in the Ohio Basin indicates the need for such recreational areas. Many of the streams also are used by large numbers of people for fishing, boating and swimming in spite of pollution which often makes swimming unsafe.

Water Supplies - Of the 2,000 public water supplies in the basin, 634 serving more than 7,000,000 people are from surface sources. Many of these surface water supplies are

FIG. 10

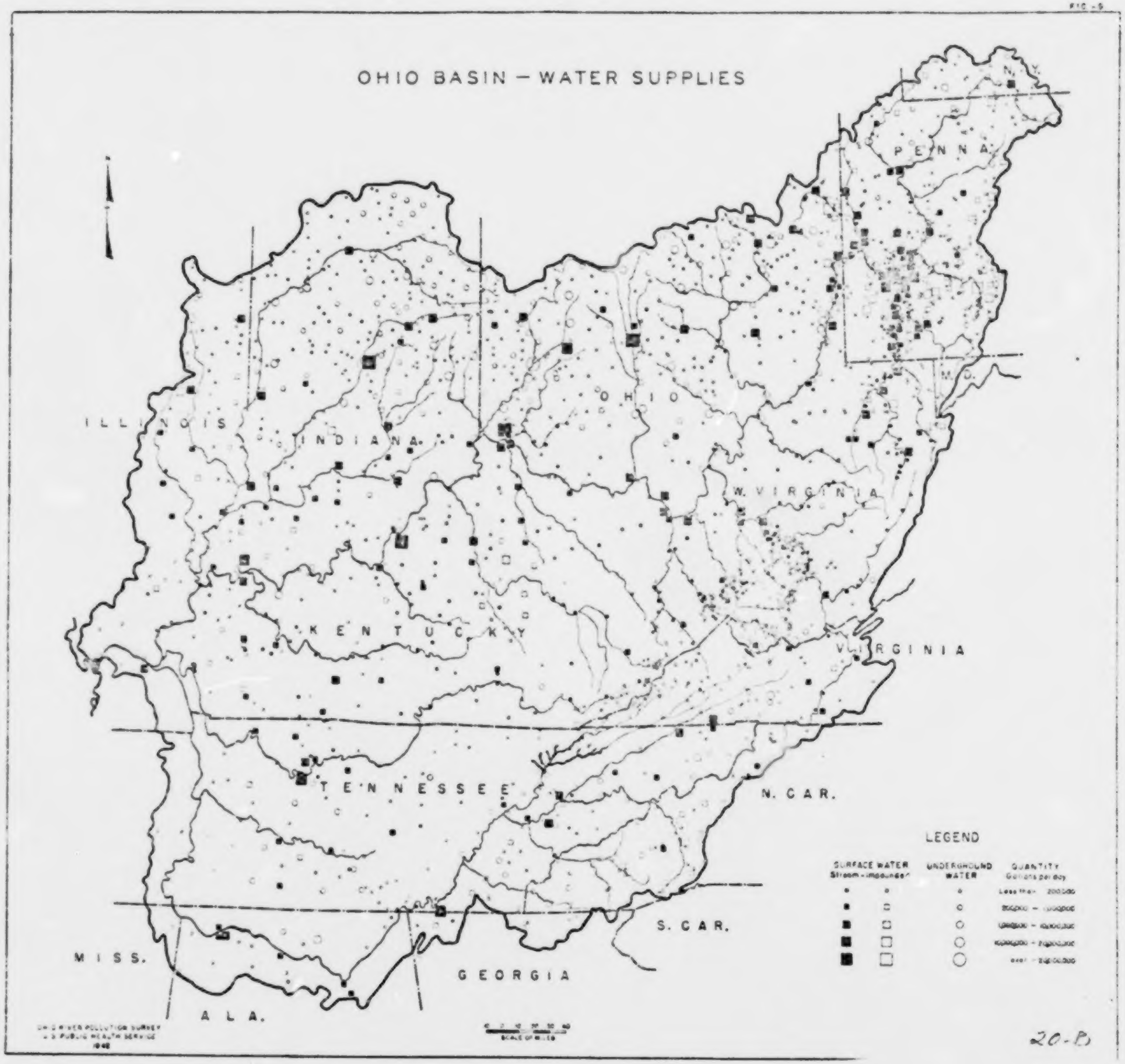
OHIO BASIN
SOURCES OF POLLUTION


N. Y.
PENNA.
MD.
OHIO
W. VIRGINIA
VIRGINIA
ILLINOIS
INDIANA
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
LEGEND
Areas of Circles Proportional to
Population Equivalent to Wastes
Before Treatment
As Discharged
Diameter
Population Equivalent
2,000,000
1,000,000
500,000
100,000
10,000
SCALE OF MILES

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
[illegible]

52-A

FIG.-5



OHIO BASIN – WATER SUPPLIES

N.Y.
PENNA.
OHIO
W. VIRGINIA
VIRGINIA
ILLINOIS
INDIANA
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
LEGEND
SURFACE WATER
Stream – impounded
UNDERGROUND WATER
QUANTITY
Gallons per day
Less than 200,000
SCALE OF MILES

Ohio River Pollution Survey
U.S. Public Health Service

20-B

from unpolluted streams or from impounding reservoirs which collect the run-off from relatively small rural areas but 294 supplies, including most of the larger ones, are from streams or reservoirs subject to some sewage pollution. These supplies serve more than 5,800,000 people. Practically all of these supplies are filtered and chlorinated and a number of them are so highly polluted that special treatment has been found necessary in order to produce a satisfactory finished water. Even after careful and complete treatment, many of the supplies are unpalatable because of obnoxious tastes which cannot be completely removed by normal treatment processes. Table 1 shows the number of supplies and the population served and Figure 9 shows the location and size of water supplies.

Industrial water demands exceed in quantity the demands for the municipal supplies. Steel, chemical, textile and paper plants, distilleries and railroads are among the largest water users and although bacterial quality is seldom of great importance except in the preparation of food products many of the industries require water of special and uniform chemical quality.

SOURCES OF POLLUTION

Sewage

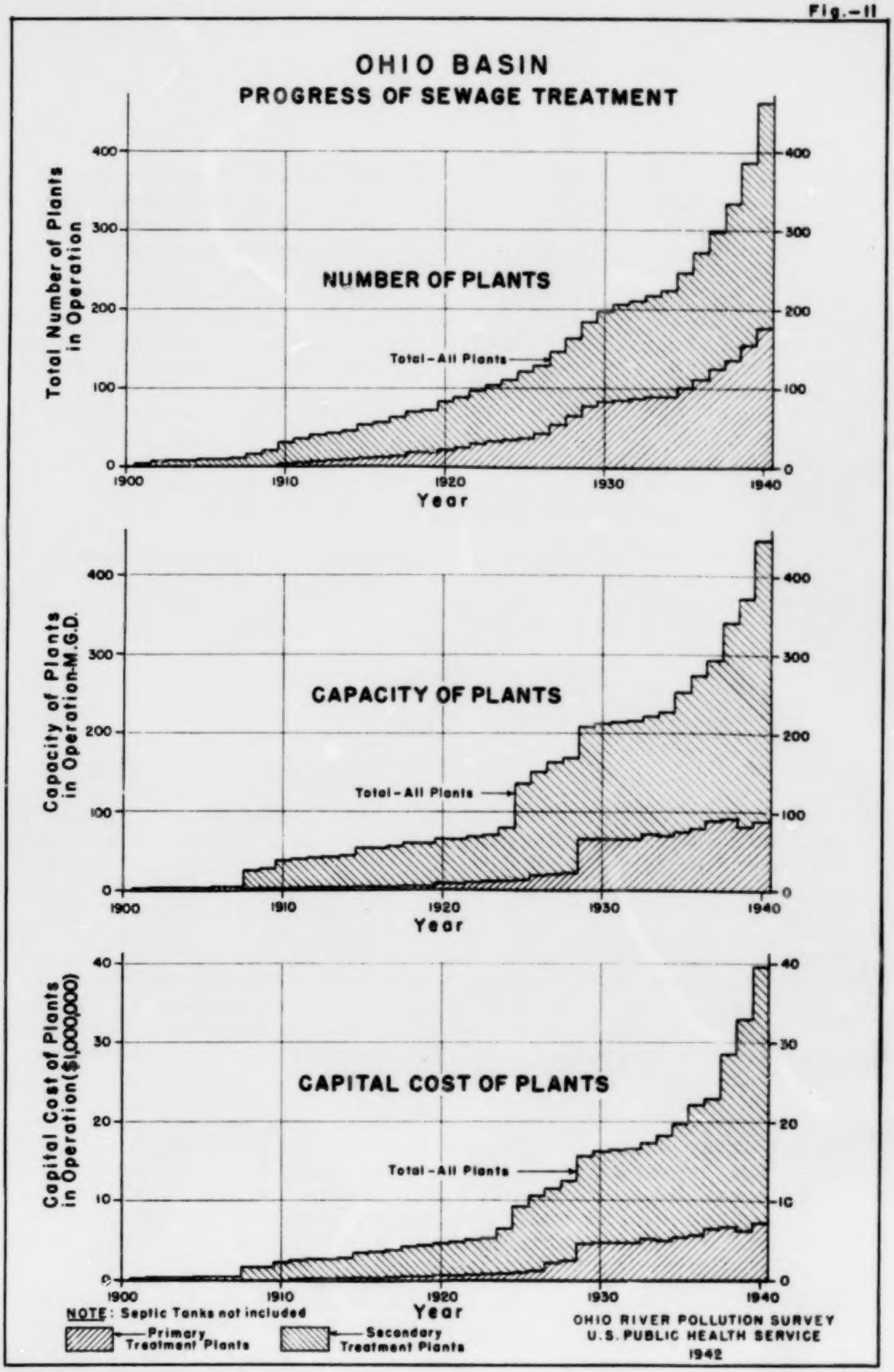
About 940,000,000 gallons of sewage enter the streams of the Ohio Basin each day. About one-third is treated to reduce its objectionable characteristics and the remainder is discharged untreated. Data on sewerage and sewage treatment are shown in Table 1. Figure 10 shows the location of the principal sources of organic wastes including both sewage and industrial wastes.

Techniques for the removal or oxidation of the organic matter and for the destruction of bacteria in sewage are well developed and it is possible to achieve almost any desired degree of purity of the effluent from a sewage treatment plant. The most common "yardsticks" for measuring the efficiency of treatment are removal of B.O.D. (biochemical oxygen demand) and suspended solids. The most common types of sewage treatment plants remove from 35 to 90 percent of the B.O.D. Their efficiency in bacterial removal is of the same order of magnitude. So-called "primary" treatment plants reduce the pollution load by about 35 percent on an average. "Secondary" or "complete" treatment plants usually reduce the pollution load by about 85 percent although there are a number of plants which average from 90 to 95 percent removal of B.O.D. Other types of plants have efficiencies between those of ordinary primary and secondary treatment. Bacterial removal can be increased most effectively and economically by chlorination of the effluent from one of the above types of treatment plants. The cost of such disinfection is relatively small as compared with other treatment costs.

It is not necessary, nor would it be economically justified, to provide complete treatment for all sewage. The capacity of streams to purify themselves is a valuable and usable asset. The necessary degree of treatment depends on the self-purification capacity of the stream or streams involved and the necessary standard of water quality to avoid undue interference with normal water uses. The effects of industrial and mining wastes often play an important part in determining the necessary degree of treatment. In some instances the problem is one of primarily local interest and importance. In other instances large streams, large areas or large numbers of people are involved and the problem assumes regional importance.

Figure 11 shows the progress that has been made in sewage treatment in the Ohio Basin since 1900. Prior to that time

Fig.-11



OHIO BASIN
PROGRESS OF SEWAGE TREATMENT

NOTE: Septic Tanks not included

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U.S. PUBLIC HEALTH SERVICE
1942

only two cities in the basin, Canton and Alliance, Ohio, had sewage treatment plants other than a septic tank. The years from 1900 to 1920 saw the invention or introduction of the principal treatment devices in common use today. The years since 1920 have witnessed vast improvements in details and an increasing trend toward mechanization of plants. Steady progress at an almost constant rate was made in the construction of sewage treatment works during the years prior to 1925. During the boom years in the latter part of the 1920's the rate accelerated but during the depression years from 1930 to 1934 such construction was practically at a standstill. The effect of various Federal aid programs is shown by the greatly accelerated progress during the years from 1935 to 1940. As much progress has been made during these six years as had been made prior to 1935.

The cost of a suggested basin-wide program of sewage treatment is shown in Table 1. The following data show the approximate number of plants that would be in operation upon completion of such a program, their capacity and cost:

	Primary	Secondary	Total
Number of Plants	650	700	1,350
Capacity (M.G.D.)	850	535	1,385
Cost*	$61,000,000	$58,000,000	$119,000,000

These data indicate that the program is now about one-third complete. A continuation of the rate of progress made during the period 1935 to 1940 for 20 more years would be required to complete the suggested program. There are no technical or engineering reasons which would prevent completion of the presented program in ten years or even less. In the few cases where research leading to the development of more efficient economical industrial waste corrective measures has been indicated, 10 years should see substantial progress. There are legal and administrative barriers which tend to delay the program. The principal problem, however, is the financing of the program.

Upon completion of the suggested program the need for construction would be reduced but not entirely eliminated. Since the average life of treatment plants in the past has been about 20 years, many of the plants already built would need to be replaced and others would need major repairs or alterations. Eventually such work would probably cost about $6,000,000 per year.

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* These costs do not include interceptors.

Industrial Wastes

Table 3 shows the number of plants of each of the principal types of industries discharging industrial wastes to the streams of the Ohio Basin and the estimated sewered population equivalent based on B.O.D. of the wastes from each type of industry. Although no single measure of pollution is applicable to all types of industrial wastes the B.O.D. is the most nearly satisfactory. Some industrial wastes contain chemicals which are toxic to aquatic life, some increase the acidity, hardness or salinity of the streams, some cause tastes and odors in water supplies, some contain undesirable coloring matter. These characteristics require separate consideration in determining how and to what degree treatment of the wastes is needed.

Reduction of industrial waste pollution is generally accomplished by one or more of the following methods:

(1) Changes within the plant itself. This may involve reuse of all or part of the waste within the plant, development of by-products, changes in plant processes, or merely greater care in plant operation to reduce the amount of material discharged as waste.

(2) Treatment with municipal sewage. Many industrial wastes can be quite effectively treated in this way. It is often necessary to pretreat the wastes at the source or to segregate certain portions of the wastes within the plant and exclude these from the municipal sewers to prevent damage to sewerage structures or sewage treatment processes.

(3) Treatment in a special industrial waste treatment plant. For many types of wastes, such plants employ essentially the same processes as sewage treatment plants. Other types of wastes require specially developed processes. Most of the plants use the principle of sedimentation for removal of settleable solids.

The first method is usually the most economical and is the one generally applied. It is occasionally possible to completely eliminate pollution and to recover valuable by-products by changes within the plant but this is not the usual situation. Ordinarily some pollution remains and some expense is involved. The second method is the simplest from the standpoint of the industry. It is also the most satisfactory from the standpoint

Table 3 Ohio River Basin - Summary Showing Industrial Wastes not Discharging to Municipal Treatment Plants, Suggested Industrial Waste Discharges to Municipal Treatment Plants and Total of Entire Industrial Waste Load in the Basin.

Industry		Number of Plants	Industrial Waste Disposal		At Least Minor Corrective Measures Taken	Estimated Sewered Population Equivalent (B.O.D.)	Suggested to Mun. Treatment	
			Munic. Sewers	Private Outlets			Number of Plants	Population Equivalent (B.O.D.)
Brewing	See Note (1)	38	35	3	27	264,300	37	263,800
By-Product Coke		23	2	21	17	745,200	2	24,300
Canning		218	52	166	160	758,900	64	310,300
Chemical		65	10	55	36	1,880,400	8	138,000
Distilling		67	14	53	53	1,009,700	20	624,600
Meat		173	76	97	115	385,700	123	323,900
Milk		253	130	123	107	85,100	167	74,700
Oil Refining		47	4	43	44	116,500	2	15,100
Paper		59	12	47	46	1,659,200	5	31,500
Steel		174	15	159	71	(2)	12	0
Tanning		32	5	27	13	269,600	13	55,400
Textile		122	57	65	10	335,100	84	216,900
Miscellaneous		333	104	229	109	160,300	89	132,500
Total		1,604	516	1,088	808	7,670,000	626	2,211,000
Industrial Wastes to Cincinnati Sewers (3)						1,108,400	-	1,108,400
Wastes Discharged to Municipal Treatment						1,195,900	-	-
Totals for the Basin						9,974,300	626	3,319,400

(1) Note: Industries occurring only once in a basin are included under "Miscellaneous" in the basin summary but are under their proper classification in this table.

(2) 336,000 pounds free acid discharged daily in waste pickle liquor.

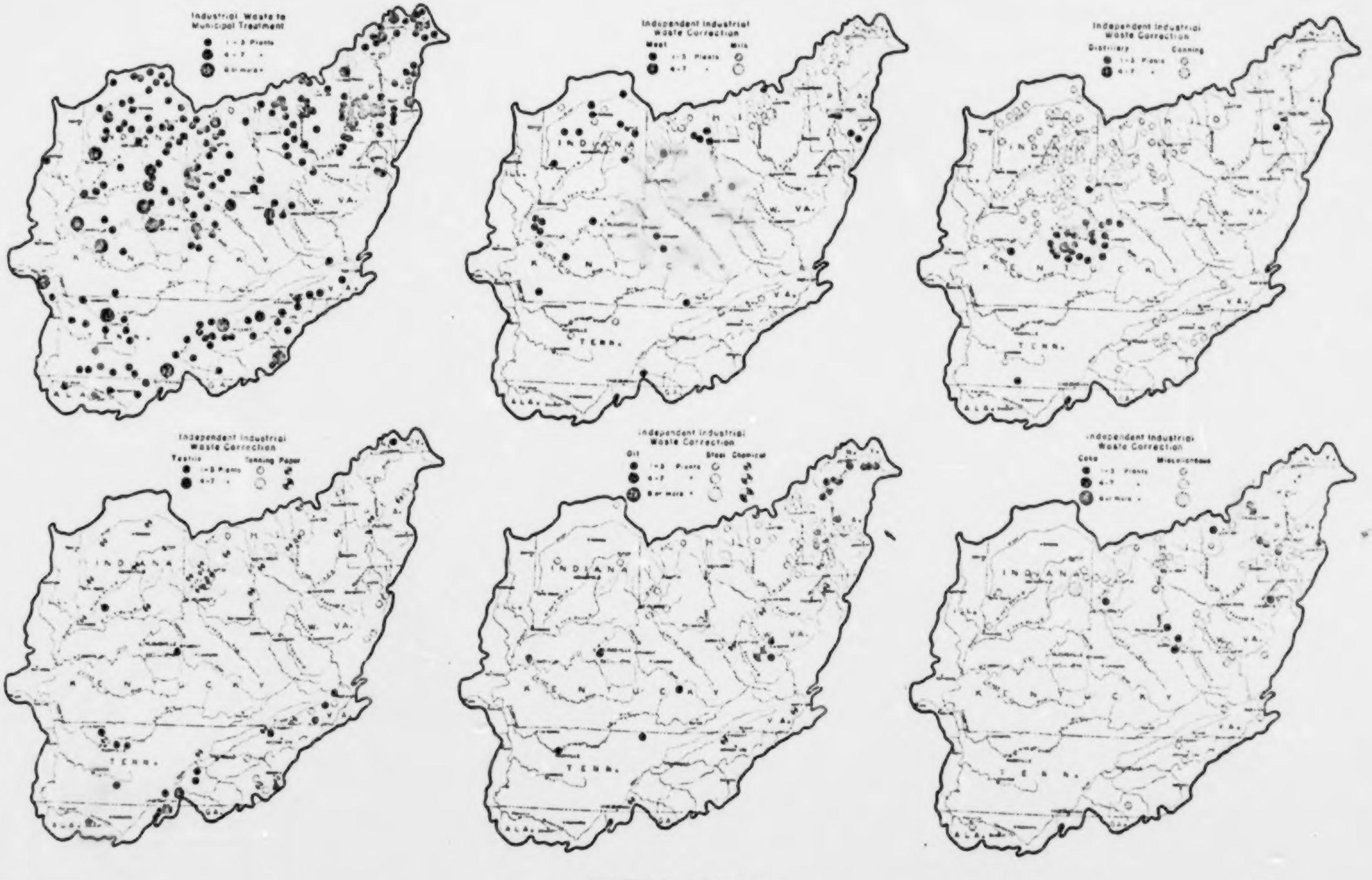
(3) Industries not surveyed individually. Population equivalent based on comprehensive sewer gaging and sampling program of city.

FIG-12

Fig-12

OHIO RIVER BASIN

SUGGESTED INDUSTRIAL WASTE CORRECTION


Industrial Waste to Municipal Treatment
● 1-3 Plants
● 4-7 "
● 8 or more
Independent Industrial Waste Correction
Meat
● 1-3 Plants
● 4-7 "
Milk
Independent Industrial Waste Correction
Distillery
● 1-3 Plants
● 4-7 "
Canning
Independent Industrial Waste Correction
Textile
● 1-3 Plants
● 4-7 "
Tanning
Paper
Independent Industrial Waste Correction
Oil
● 1-3 Plants
● 4-7 "
● 8 or more "
Steel
Chemical
Independent Industrial Waste Correction
Coke
● 1-3 Plants
● 4-7 "
● 8 or more "
Miscellaneous
INDIANA
OHIO
KENTUCKY
W. VA.
VA.
TENN.
ALA.
GA.
25 0 25 50 75 100 125 150 175 200
SCALE OF MILES

NOTE - Exclusive of plants where present corrective measures are adequate

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1942

of administration of pollution abatement programs since it reduces the number of possible sources of pollution and concentrates responsibility for effective waste treatment. It is usually necessary to make special provisions in the design of a municipal sewage treatment plant if an appreciable amount of industrial waste is to be treated. Subsequent changes in the industrial waste load sometimes cause difficulties. The third method is used when the first is insufficient and the second impracticable. In those cases where removal of settleable solids is sufficient the problem is not difficult but satisfactory methods for the relatively complete removal of B.O.D. are available for only a few of the more common types of wastes such as those from breweries, meat plants, milk plants, and some types of canneries and distilleries. There is a pressing need for the development of more efficient and economical methods for relatively complete treatment of other types of wastes. More complete discussions of industrial wastes and their treatment are found in the "Industrial Waste Guides" included as a supplement to this report.

Figure 12 shows the location of industrial plants of various types which will probably require individual remedial works and the location of industrial plants of all types which can probably be connected to existing or proposed municipal treatment works.

Acid Mine Drainage

The problem of acid mine drainage is one of the most pressing in the Ohio River Basin. Data relative to the discharge of the present acid load of 1,800,000 tons of mine acid per year are presented and discussed in a separate section of this report and in a more detailed supplement.

WATER QUALITY

As a background for the presentation and discussion of extensive laboratory data, particularly in the individual summaries, a discussion of water quality requirements for various uses has been prepared. This is followed by a discussion of present water quality which summarizes briefly the quality of stream water in the basin as a whole. More detailed discussion and either individual or monthly average results are given in the basin summaries. A further discussion of results plus a detailed outline of methods is presented in a supplement.

Water Quality Requirements

As a basis of comparing the sanitary conditions in streams of the Ohio River Basin from laboratory observations of their waters at various points, it is desirable to consider briefly the limiting characteristics of stream waters in general, when expressed in terms of laboratory data, which may serve to distinguish between suitable and unsuitable conditions for different water uses.

Of the more common water uses in the Ohio Basin, the most important one is public water supply, because a large proportion of the population resident in the basin is dependent on surface sources of water for domestic and other essential uses. Secondary but also highly important is the growing use of natural waterways for recreation, together with the continuing need for support of fish and other higher aquatic life in streams. This latter need, though it bears a definite relation to recreational use of streams, is of much broader and more fundamental significance, as it has a direct bearing on the ability of all natural watercourses to maintain their normal capacity for self-purification.

Among other stream uses which are affected to some extent by sanitary conditions are those which have to do with industry, agriculture, navigation and general community development. In a broad sense, industrial needs for water are fairly similar to those of domestic supply, except that in some instances they have special requirements, either more or less rigid. In the Ohio Basin, agricultural use of surface water is mainly concerned with stock raising, as a large majority of farms have their own private wells for domestic supply, and irrigation is not a general problem. Navigation is affected by acid pollution and resulting corrosiveness and hardness of stream waters for boiler use. It also is adversely affected by gross sewage pollution which may cause "nuisance" and sludge banks. Community development is hampered, sometimes very materially, by poor sanitary conditions in streams which not only may cause serious damage to riparian property values, but also may interfere with the provision of desirable water-front highways, parkways, public landings and industrial docking facilities.

In order to systematize the discussion which follows, it will be convenient to consider the requirements for stream waters in terms of each separate characteristic as determined by the usual laboratory tests. In this connection, it is assumed that the methods of conducting the laboratory tests would conform very strictly to those of the latest "Standard Methods" of the American Public Health Association, as noted elsewhere in this report.

Coliform Bacteria

Bacteria of the coliform group are normal inhabitants of the intestinal tract of warm-blooded animals, including man, and are present in very high numbers in domestic sewage. As an index of sewage pollution, the number of coliform bacteria in a stream water is the most sensitive and reliable single determination available to the sanitarian. This number may be expressed in terms of the older "Phelps Index" or in terms of the more recent "most probable number" (M.P.N.). The latter method of enumeration has been followed throughout the present report.

Although the coliform bacteria number is used as an index of general sanitary conditions in natural bodies of water polluted by sewage, its more important applications are in judging as to the sanitary fitness of water supplies and their sources and of bathing waters. In flowing streams, progressive changes in the density of coliform bacteria below sources of pollution afford a valuable indication of the extent and rapidity of self-purification, after making due allowance for the effects of intermediate pollution and dilution. In interpreting the results of stream observations, the location of water supply intakes and bathing places with reference to sources of pollution is an important matter for consideration in connection with coliform data.

Water Supply - Several years ago the Public Health Service conducted an exhaustive study (1) of the limiting densities of coliform bacteria in river and lake waters subjected to various degress of purification, having particular reference to the production of finished waters meeting the bacteriological requirements of the Public Health Service's drinking water standards as promulgated in 1925(2). The results of this study indicated that the average efficient water filtration plant, with postchlorination of the effluent included, can purify to the drinking water standards level a raw water having an average number of coliform bacteria up to 50 per ml. (or 5,000 per 100 ml. Assuming that a drinking water of standard quality from this standpoint were judged on the basis of monthly average results of coliform determinations, this would imply that the raw water as delivered for treatment should not contain more than 50 per ml. of coliform bacteria, as an average, during any month, if the limit of safe loading were not to be exceeded. This limit has been adopted by a number of states as a criterion in judging as to the fitness of sources of water supply subjected to ordinary filtration treatment for public use. Parallel studies indicate that the change from the Phelps index to most probable numbers has little effect on the conclusions of the original studies.

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(1) Public Health Bulletins Nos.172 and 193; Public Health Reports, Reprints Nos.1114, 1170, 1392, 1434 and 1565. U. S. Public Health Service, Washington, D.C.

From the same study as above noted, two other coliform bacteria limits were determined which are of interest in this discussion. One was the upper limit of average coliform density, amounting to about 0.5 per ml. (or 50 per 100 ml.) which would permit the production of an effluent of standard quality by simple chlorination alone.

The second was the observation that when the ordinary filtration plant is reinforced by continuous prechlorination of the raw water in addition to postchlorination, the permissible maximum limit of coliform density in the raw water may be increased to about 200 per ml. (or 20,000 per 100 ml.). In this latter case, however, it was observed that raw waters showing monthly average coliform densities ranging from 50 to 200 per ml. are in general unsatisfactory as sources of purified water supplies as they are likely to exceed coliform densities of 200 with a frequency ranging from over five to twenty percent of the time and thus overburden even a reinforced filtration plant for a correspondingly high proportion of the time. With raw waters polluted to this extent, moreover, difficulties of delivering palatable as well as safe effluents are increased, because of the presence of taste-producing substances originating both in sewage and in certain industrial wastes. These waters must be considered therefore, as being of doubtful fitness as sources of water supply

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(2) Public Health Reports, April 10, 1925, pp. 699-721, (Reprint No.1029).

From these considerations the following general rules may be stated as to the fitness of stream waters as sources of public water supply, when related to their average coliform bacteria number during any month:

Limiting Average Monthly Coliform Number per ml.	Relative Fitness
0 - 0.5	For purification by simple chlorination.
0.5 - 50	For purification by filtration and postchlorination.
50 - 200	Doubtful - unfit for ordinary filtration treatment. (Unsuitable if greater than 200 in more than 5 percent of samples).
Over 200	Unfit for treatment.

Bathing Waters - Existing standards of quality for natural bathing waters, as distinguished from artificial pools, are highly variable among the different states and appear to be governed more by expediency than by any well established observational data. The most reliable data bearing on the relation between observed quality of bathing waters and sanitary conditions affecting such waters as determined by physical surveys have come from Connecticut, where two studies of this kind have been made. Winslow and Moxon (3), as the result of their study of bathing beaches near New Haven, recommended a standard providing an average coliform number not over one per ml. and a maximum number not over 10. Scott (4), on the basis of a survey of beaches along the Connecticut shore of Long Island Sound, set up four classes of bathing waters, based on coliform numbers. The best class, A, showed average numbers from 0 to 0.5 per ml. This class Scott considered as definitely good, Classes B and C, rated as doubtful, showed ranges of 0.51-5 and 5-10, respectively. Class D, judged as very poor, gave average numbers over 10. The Tri-State Pollution Commission has adopted Scott's class A as the basis of requirements for natural bathing waters in the New York area.

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(3) Bacterial Pollution of Bathing Beach Waters in New Haven Harbor. C-E. A. Winslow and D. Moxon. Amer. Journal Hyg., 8, 3, 299-310, May, 1928.

(4) American Public Health Association. Reports of Joint Committee on Bathing Places.

From the evidence above cited, it would appear that the highest standard thus far proposed as the result of actual laboratory and sanitary surveys would conform to Scott's Class A, though the Winslow-Moxon criterion, which also is based on good observational data, is nearly as high in its average requirements. For inland streams, the Winslow-Moxon standard might appear more reasonable, as it permits a degree of variability which is inherent in all stream waters. Bearing in mind that the M.P.N. method of coliform enumeration tends to give somewhat higher results than does the Phelps index method, the Winslow-Moxon criterion, based on M.P.N's., would be sufficiently rigid to be comparable to Scott's Class A requirement when expressed in terms of the Phelps index. This requirement would appear to be a reasonably safe one for bathing waters in the Ohio River Basin.

Dissolved Oxygen

In unpolluted streams, the dissolved oxygen content tends to remain at or very near the saturation level. In polluted streams, it is depressed temporarily below points at which wastes are discharged into the stream, but tends to move gradually upward toward the saturation level along the familiar "oxygen sag curve." The depth of the oxygen depression below saturation at the prevailing stream temperature is an index of the intensity of pollution in that particular stream zone. In streams only slightly or moderately polluted, the dissolved oxygen content usually remains above a level of 70 to 80 percent saturation. In grossly polluted streams, it may reach zero saturation, or total depletion, and remain thus throughout stretches of considerable length, particularly in summer low flows where underlying sludge deposits exist. Between these two extremely divergent oxygen levels are numerous intermediate ones, indicating various gradations of pollution between moderate and gross.

The minimum oxygen requirements for streams are, in general, dependent on the particular uses to which they are devoted, though two or three p.p.m. of oxygen in a stream usually marks the extreme minimum level. Septic conditions and general "nuisanc follow inevitably the continuance of oxygen levels at or near the zero point.

For maintenance of native fish life Ellis (5) states, from studies by the Bureau of Fisheries, that an oxygen minimum of five p.p.m. is necessary. Although many fish of the more hardy varieties will survive at oxygen levels of four or even three p.p.m., he shows that the metabolic processes of most common fish are hampered at levels below five p.p.m. and points out that the mere survival or tolerance level is too low to permit the breeding and self-maintenance of the desirable forms of native fish.

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(5) Detection and Measurement of Stream Pollution. M.M.Ellis, Bull. 22, U. S. Bureau of Fisheries, 1937.

Ellis' conclusions have been confirmed fully by the biological observations made in connection with the present Ohio River Pollution Survey (6). These observations, as described in a supplement of the present report, have indicated that in regions of heavy pollution, with dissolved oxygen below three p.p.m., fish are mostly absent, with occasional carp, buffalo and sunfish. In zones of "intermediate" pollution, with dissolved oxygen three to five p.p.m., fish are more abundant, but "showing a tendency to sickness, deformity and parasitization." In "fertile" zones, with dissolved oxygen not below five p.p.m., it has been observed that "fish are varied, plentiful and healthy," with large numbers of market fish present. In "game fish" zones, where oxygen is always above five p.p.m., and usually near saturation, the presence of basses, perches, pike and forage fish has been noted.

The striking agreement thus shown between the findings of the present survey and those of Ellis from his previous survey would seem to leave no room for doubt as to the validity of the conclusion reached by both observers concerning the desirability of a five p.p.m. oxygen minimum in stream zones where the proper maintenance of native fish life is an important consideration.

On the basis of stream uses and conditions, the following summary may be given of the oxygen status of streams, from present evidence:

Minimum Daily Average Dissolved Oxygen p.p.m.	Stream Conditions
0 - 3	Heavy pollution, probable nuisance at times, little fish life.
3 - 5	Moderate to heavy pollution, no nuisance, fish life restricted to coarse species.
Over 5	Slight to moderate pollution, fish life varied, abundant and healthy, game fish at higher minimum levels.

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(6) Ohio River Pollution Survey - Report of Biological Studies. Supplement "F" to this report.

In general, the minimum oxygen ranges above given might be considered as minimum daily averages. When expressed in terms of averages for periods of several days up to a month, it would be desirable to add about 1.5 to 2 p.p.m. to each daily minimum figure in order to safeguard against daily variations below the period average. Figure 12a, page 35, shows the relationship between monthly average and minimum daily dissolved oxygen results based on the results of 7,500 samples collected during the present and previous surveys of the Ohio River and its tributaries. In order to assure the maintenance of a five p.p.m. daily minimum, a period average up to a month would be set at a minimum of 6.5 or 7 p.p.m.

A possible question might be raised as to whether it may be necessary or even desirable to maintain a five p.p.m. oxygen minimum in all parts of a stream, including limited zones immediately below sources of pollution. It may be argued with some reason that it is not essential to the general support of fish life in streams to maintain such life unimpaired at all points, so long as the minimum dissolved oxygen does not fall below limits of tolerance for fishes, permitting them to pass through certain zones in order to reach their normal breeding places. Where sources of pollution are isolated and well separated by zones of active stream recovery, it is quite possible that an oxygen minimum of four p.p.m. in limited zones immediately below each source of pollution would be permissible. Where these sources are not isolated but are located so closely together that recovery is not possible within a reasonable distance, a definite hazard to fish life then may exist, even if a four p.p.m. minimum is maintained, in preventing the free movement of fish from one recovery zone to another. In general, it may be said that a five p.p.m. minimum is desirable, except where local conditions may be favorable to allowing a four p.p.m. minimum in limited zones immediately below fairly isolated sources of pollution.

Biochemical Oxygen Demand

In connection with the present Survey, a marked degree of correlation has been shown between the observed 5-day biochemical oxygen demand of stream waters at points immediately below sources of pollution and known densities of pollution at these points. A similar correlation has been shown between the 5-day B.O.D. and the numbers of coliform bacteria as observed at the same sampling points. In view of these relationships, an effort has been made to ascertain, from a study of the labora-

Fig.-12a.

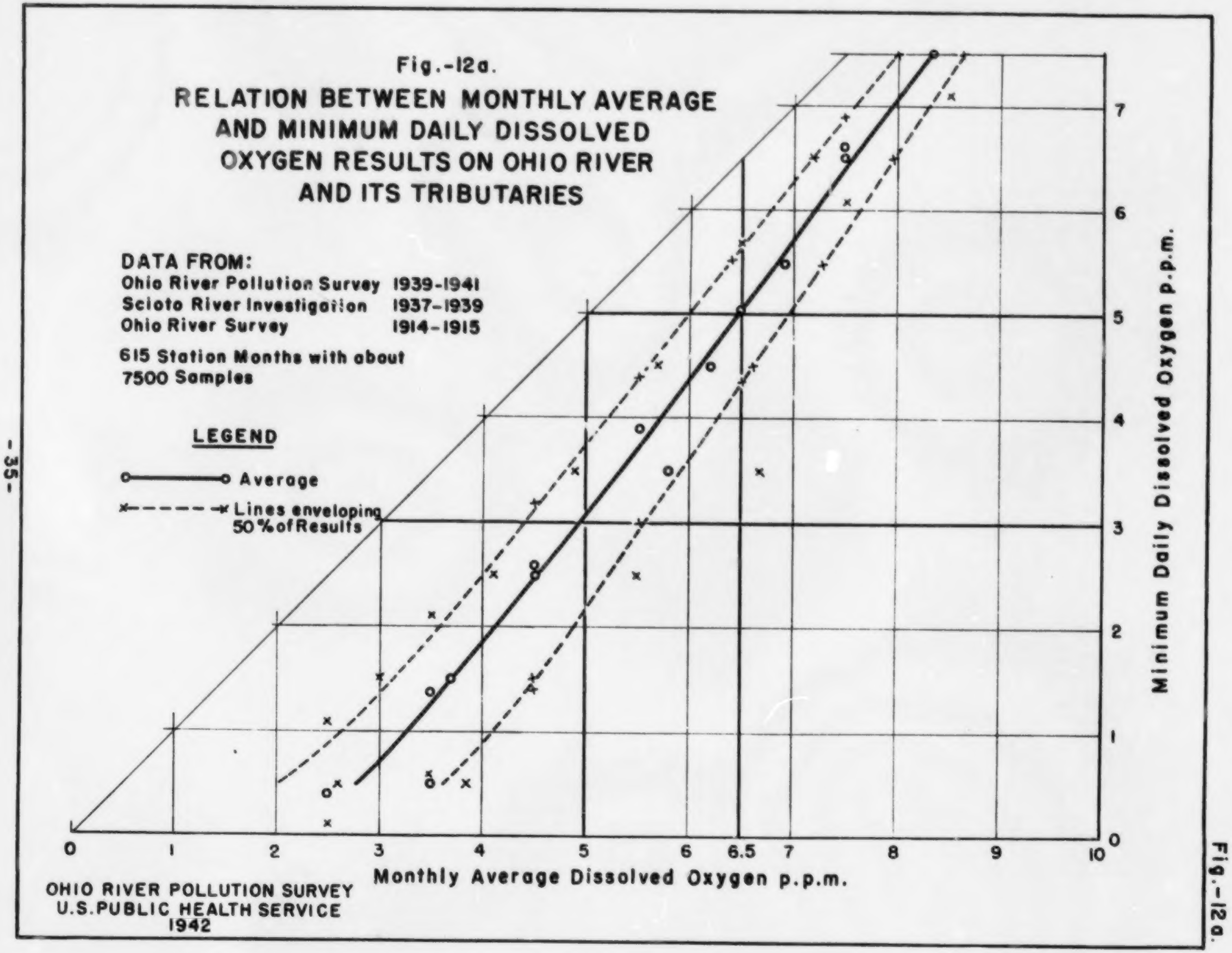

Fig.-12a.

RELATION BETWEEN MONTHLY AVERAGE AND MINIMUM DAILY DISSOLVED OXYGEN RESULTS ON OHIO RIVER AND ITS TRIBUTARIES

OHIO RIVER POLLUTION SURVEY
U.S.PUBLIC HEALTH SERVICE
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tory data, the approximate ranges of B.O.D. which may serve to distinguish between stream waters of various degrees of pollution, such as heavy, moderate and slight. A source of difficulty in this connection lies in the considerable variability with which natural purification appears to affect the observed B.O.D. in streams of different sizes. In small and shallow streams, observed B.O.D. tends to diminish very rapidly under low-flow conditions, partly because of sedimentation, but also probably because of conditions favorable to rapid oxidation by growths of bacterial flora resembling activated sludge, attached to the sides and bottom of the channel. In larger streams, this effect is generally less marked, possibly because of the lesser effect of these bacterial growths.

In general, it has been observed that stream waters in the Ohio River Basin only slightly or very moderately polluted tend to show 5-day B.O.D. values averaging less than three p.p.m., with relatively low numbers of coliform bacteria and dissolved oxygen contents ranging above five or six p.p.m. In moderately polluted streams the B.O.D. may range from three to five p.p.m., with correspondingly higher coliform numbers and somewhat lower dissolved oxygen levels, though in the latter case exceptions may occur when the observations are made at points very close to sources of pollution, where the full effect of the "oxygen sag" curve has not yet become manifest.

The gradations in B.O.D. may, therefore, be summarized about as follows:

Maximum Monthly Average 5-day B.O.D., p.p.m.	Stream Conditions
0 - 3	Slight to moderate pollution.
3 - 5	Moderate to moderately heavy pollution.
Over 5	Heavy pollution.

A complicating element in interpreting the results of B.O.D. tests is found in acid streams receiving mine wastes. Under these conditions, little if any direct correlation exists between the observed B.O.D. and the density of pollution.

Sludge Deposits

Organic sludge deposits may be formed in streams as the result of discharging raw sewage and certain types of industrial wastes. Where present, they tend to impose an added burden on the oxygen resources of a stream and also to exert a very damaging effect on fish life. When present in large amounts, sludge deposits may bring about septic conditions, with a consequent breaking down of the self-purification capacity of the stream and depletion of the dissolved oxygen supply in the overlying water. Loss of fish life is due to suffocation from oxygen depletion, to toxic effects of heavy pollution and to interference by sludge deposits with the spawning process, on which depends the normal reproduction of fish. An additional effect of extensive sludge deposits is the presence of floating solids and often obnoxious odors resulting from anaerobic decomposition of the deposits.

From these considerations, it is evident that the maintenance of desirable stream conditions necessitates the practical absence of organic sludge deposits originating in sewage and certain types of industrial wastes. Where these deposits are localized, small in extent and subject to frequent removal by the flushing action of increased stream flows, their effects on a stream may not be very far-reaching. Nevertheless, they are always a detriment and should be eliminated so far as possible from streams in which it is desired to maintain healthy conditions.

Alkalinity, Acidity and Hydrogen-Ion Concentration

The normal alkalinity of streams in the Ohio River Basin varies widely, even where uncomplicated by acidity from mining and steel mill wastes. In the Ohio River proper and its major tributaries at their mouths, the alkalinity tends to range from about 30 to 200 p.p.m., depending on the geological character of the watershed and particularly the extent of limestone formations. In a very few streams near the headwaters of some tributaries, normal alkalinities as low as 20, 15 p.p.m. or even lower, have been recorded. Ordinarily, the alkalinity tends to range above 30 or 40 p.p.m. over a large portion of the Basin.

Acidity in Ohio River streams is due to the effect of mine wastes and in some local areas, of steel mill wastes, though the former constitutes by far the larger sources of acid pollution. The pH values range accordingly from as low as 2.0 or 3.0 in highly acid streams to as high as 8.0 or more in highly alkaline streams.

In general, it is desirable to have not less than 15 or 20 p.p.m. of natural alkalinity in stream waters used as sources of water supply, owing to the absorption of alkalinity by coagulants most commonly used in water purification. Acid

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waters can be treated, by adding alkalinity in the forms of lime or soda ash, but the expense of treatment is increased accordingly, and their "permanent" or scale-forming hardness is also increased. Where acidity is highly variable, difficulties occur in water treatment because rapid changes in the acidity, if not promptly corrected, may result immediately in improper coagulation, or even in nullifying it completely.

According to Ellis' findings, the water of flowing streams tends to range from pH 6.7 to pH 8.6, where unpolluted by municipal or industrial wastes. When more acid than pH 6.7, or more alkaline than pH 8.6, as the result of pollution, he states that the buffer and carbonate systems are usually so disturbed that conditions harmful to fish are generally found. This natural range is, therefore, the most desirable one for maintenance of healthy fish life in streams. Ellis states further that pH 4.0 or less is definitely lethal to all fish. He points out, however, that in determining the lethality of acid wastes, the specific acid involved must be considered, as "acid wastes do not kill merely because of a particular degree of acidity." Reviewing all of the data on acid wastes, he states that the truly acid effects must be limited to those acids which kill at pH values less than 5.0, whereas in the case of acids killing at pH values more than 5.0, lethality factors other than hydrogen-ion concentration play the major part.

From these considerations, it would appear that pH 5.0 marks the lowest safe minimum value for maintenance of normal fish life in streams, when expressed without reference to the particular kind of acidity involved. As an upper limit of alkalinity, that which corresponds to pH 9.5 may be regarded as the maximum tolerable value. The following summary of variation limits, expressed in terms of the pH value, may be useful in this connection:

Average Daily pH Values	Stream Conditions
6.5 - 8.6	Normal for unpolluted streams, favorable to fish life, suitable for water supplies.
5.5 - 6.5	Moderate acid pollution, tolerable to fish life, suitable for water supplies prior to treatment.
4.0 - 5.5	Moderately heavy acid pollution; detrimental to fish life, fairly suitable for water supplies prior to treatment.
Less than 4.0	Heavy acid pollution, lethal to fish life, unfavorable for water supplies prior to treatment.

Table 4, page 41 presents a condensed summary of the limiting characteristics of stream waters considered, respectively, as "desirable," "doubtful" and "unsuitable" from the standpoint of combined water uses. For water supplies, the requirements in respect to coliform bacteria, pH and phenols are of more importance. For fish life maintenance, dissolved oxygen, B.O.D., pH values and sludge deposits are especially significant.

Discussion

According to the evidence at hand the water characteristics designated as "desirable" and "unsuitable" in the summary table appear to fall quite definitely into these two opposite categories. The intermediate or "doubtful" group defines characteristics which may be tolerable but undesirable, or may approach unsuitability, according to their relative position in the ranges given. No hard and fast line may be drawn for this "doubtful" group, but some degree of flexibility in judgment must be exercised in individual cases.

The requirements set forth in these three categories have not been intended to constitute a formal classification of stream waters in the Ohio River Basin, so far as the present report is concerned. It is fairly evident, however, that the mere endeavor to define stream characteristics in terms of their relative suitability for various water uses involves, in effect, the principle of classification, whether or not this term be used in this connection. It also involves the idea of stream standards, which form an essential part of any system of stream classification.

The application of the tentative limiting requirements for stream water quality, as set forth in this chapter, to the estimation of corrective measures for pollution in any given stream zone would involve four steps as follows:

(1) Determination of essential or desirable stream uses in the particular zone concerned.

(2) Fixing of necessary requirements for stream water quality in the zone, based on "essential" or "desirable" uses as defined under (1).

(3) Determination of existing stream conditions in the zone, based primarily on systematic laboratory observations above and below known sources of pollution and at other significant points.

(4) Estimation of necessary corrective measures for pollution loading at specific points, in order to meet essential or desirable stream quality requirements, on the basis of existing stream conditions and known pollution loadings at such points.

In interpreting the results of laboratory observations, due account should be taken of flow and seasonal conditions prevailing during the periods of the observations, with special reference to those conditions which might be considered as critical for the particular water uses involved. If the results observed at any time were definitely bad or unfavorable, such a finding would be significant regardless of whether or not the flow conditions were at a "critical" level. If the results at such a time were favorable and stream conditions were not at the "critical" level, then the possibility of unfavorable findings under conditions approaching more closely the critical point would have to be considered. In this connection, it should be pointed out that "critical" stream conditions would vary to some extent according to the particular water use involved. Where recreational use, maintenance of fish life, or prevention of "nuisance" is concerned, critical stream conditions usually coincide with those of extremely low water in the mid or late summer. For water supplies, the more critical conditions often occur following major rises in streams during the winter or spring months, when the effects of sewage pollution and of scoured sludge deposits at downstream points are at a maximum.

Table 4 - Ohio Basin - Water Quality Requirements - Summary of Limiting Quality Requirements for Stream Waters with Principal Stream Uses and Conditions Involved in Each Category. (These values should not be arbitrarily applied to streams other than those of the Ohio River Basin as each stream should be reviewed in the light of its own peculiar biological characteristics.)

		Desirable	Doubtful	Unsuitable
Coliform Bacteria per ml.	Average	Water Supply - General Sanitary Conditions Not over 50 in any month. (Filtration treatment required if over 0.5)	50 - 200 in any month Unsuitable if greater than 200 in more than 5 percent of samples.	Over 200 in any month.
Coliform Bacteria per ml.	Average Maximum	Bathing - Recreation Not over 1.0 Not over 10.0	1.0 - 10.0	Over 10.0
Dissolved Oxygen p.p.m.	Average Minimum	Fish Life-Recreation-Gen'l Sanitary Conditions Not less than 6.5 in any month Not less than 5.0 on any day	5.0(1) - 6.5 in any month 3.0 - 5.0 on any day	Less than 5.0 in any month.(1) Less than 3.0 on any day.
5-day B.O.D. p.p.m.	Average	General Sanitary Conditions - Recreation Not over 3.0 in any month.	3.0 - 5.0 in any month.	Over 5.0 in any month.
pH		Water Supply-Fish Life-Recreation-Navigation Industry 6.5 - 8.6	4.0 - 6.5 or 8.6 to 9.5(2) Suitable for water supply prior to treatment	Less than 4.0 or over 9.5(2) Unfavorable for water supply prior to treatment.
Sludge Deposits		Fish Life-Recreation-General Sanitary Conditions No preventable deposits present.	Slight to moderate-localized.	Moderate to heavy - general.
Phenols p.p.b.		Water Supply Not over 1	1 - 10	Over 10
Other Conditions		Water Supply - Recreation - Fish Life No toxic substances, oils, tars, or free acid at any time; no floating solids or debris, except from natural sources; no taste-producing substances.	Free Acidity at any time, chlorides over 250 p.p.m.; occasional taste-producing substances.	Toxic substances, oils or tars present at any time; free acidity present frequently; taste-producing substances present frequently.

(1) In general, it may be said that a five p.p.m. minimum is desirable, except where local conditions may be favorable to allowing a four p.p.m. minimum in limited zones immediately below fairly isolated sources of pollution. See discussion, page 34.

(2) Tentative drinking water standards permit pH 10.6 in "treated" water.

Present Water Quality

As a means of indicating the effect of existing pollution in the basin on the sanitary quality of the water, the laboratory results have been grouped on the basis of concentration of coliform organisms, dissolved oxygen and biochemical oxygen demand as outlined in the section on water quality requirements.

Table 5 summarizes the results of coliform organism and B.O.D. tests. The table shows the number of stations in each basin at which the worst monthly average results were within various ranges.

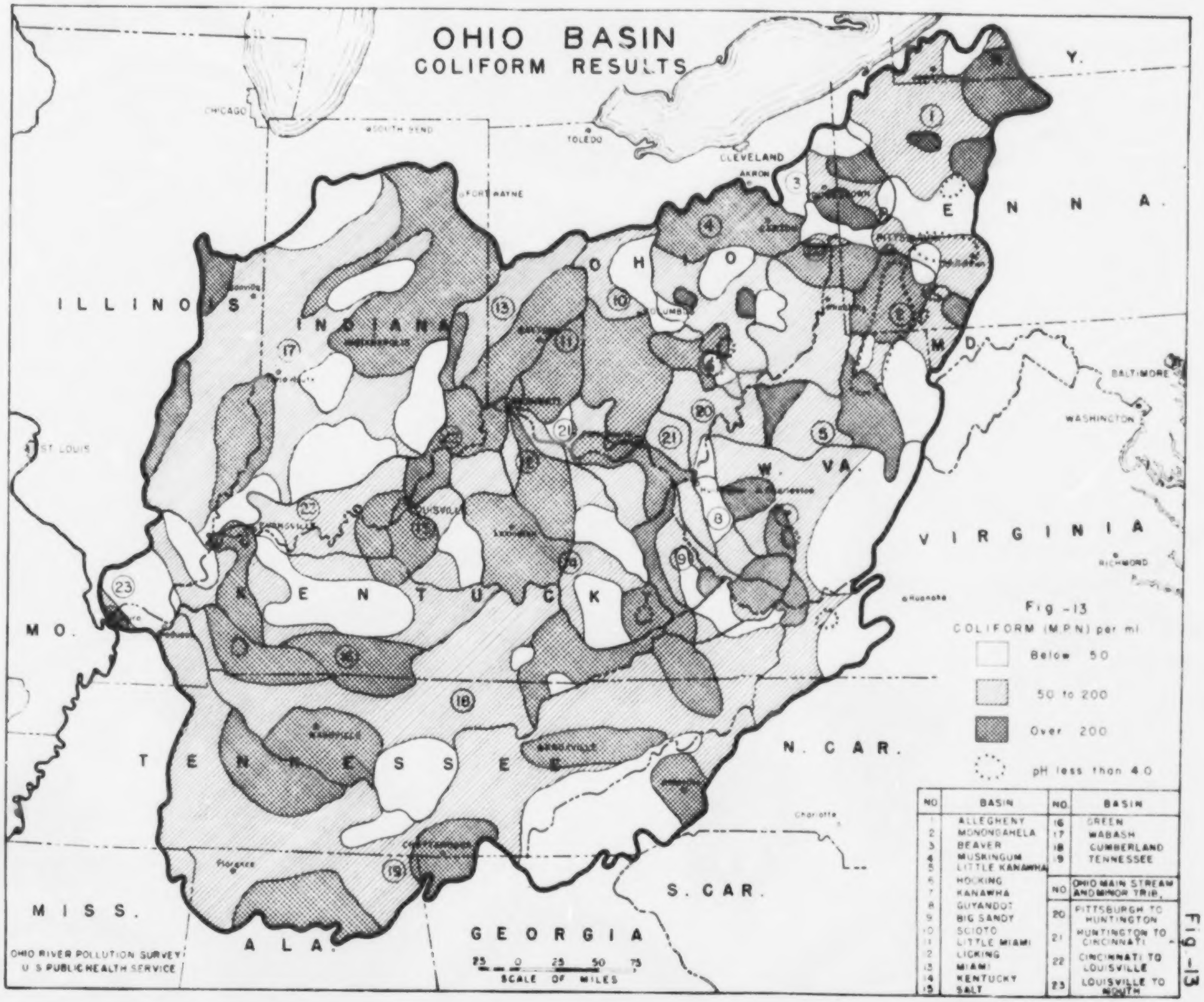
In general, the largest number and highest percentage of stations falling within the lowest range of coliform densities (0 to 50 per ml.) and biochemical oxygen demand concentrations (0 to 3 p.p.m.) indicate the better sanitary quality of the waters of the basin subdivision. Conversely, the largest number of stations and highest percentages of the stations falling in the higher ranges of coliform density (over 200 per ml.) and biochemical oxygen demand concentration (over 5 p.p.m.) indicate more highly polluted conditions of the waters of the basin and less desirable water for domestic supply and other customary uses.

The tabulations of coliform organisms show clearly the effects of acidity in the tendency for higher percentages of the stations in acid streams to show coliform numbers in the lower density range as contrasted with the corresponding percentages for the normal alkaline streams.

On Figures 13 to 15 the average analytical results for the entire basin have been grouped to show graphically areas of comparable sanitary quality of the streams as indicated by the particular determination used as the index.

Coliform Bacteria - Figure 13, based on the determination of coliform bacteria, shows, by the heavier shading, areas in which the highest monthly average numbers of coliform bacteria exceeded 200 per ml. Lighter shaded portions show areas in which the highest monthly average number of coliform organisms was between 200 and 50 per ml. and the unshaded areas show, in general, areas with coliforms less than 50 per ml.

In general, 50 coliform organisms per ml. represent the desirable upper limit of bacterial concentration for sources of water supplies. In all areas except those included


OHIO BASIN
COLIFORM RESULTS
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
AKRON
FORT WAYNE
ILLINOIS
INDIANA
OHIO
Y.
PENNA.
MD.
BALTIMORE
WASHINGTON
W. VA.
VIRGINIA
RICHMOND
Roanoke
ST. LOUIS
MO.
KENTUCKY
TENNESSEE
N. CAR.
Charlotte
S. CAR.
GEORGIA
ALA.
MISS.
Florence
Fig -13
COLIFORM (MPN) per ml
Below 50
50 to 200
Over 200
pH less than 4.0
1
3
4
5
8
9
10
11
13
15
16
17
18
19
20
21
22
23
25 0 25 50 75
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
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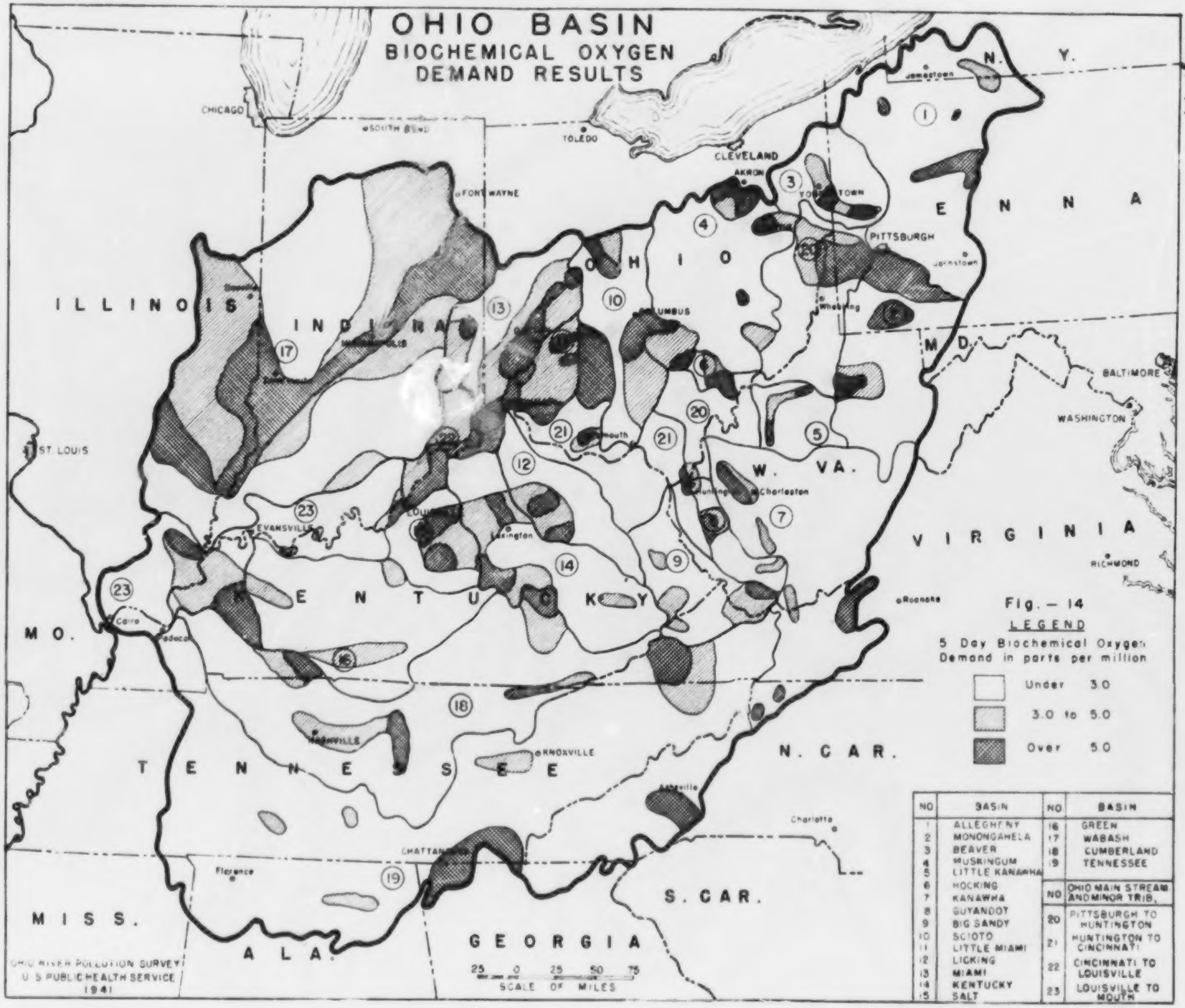
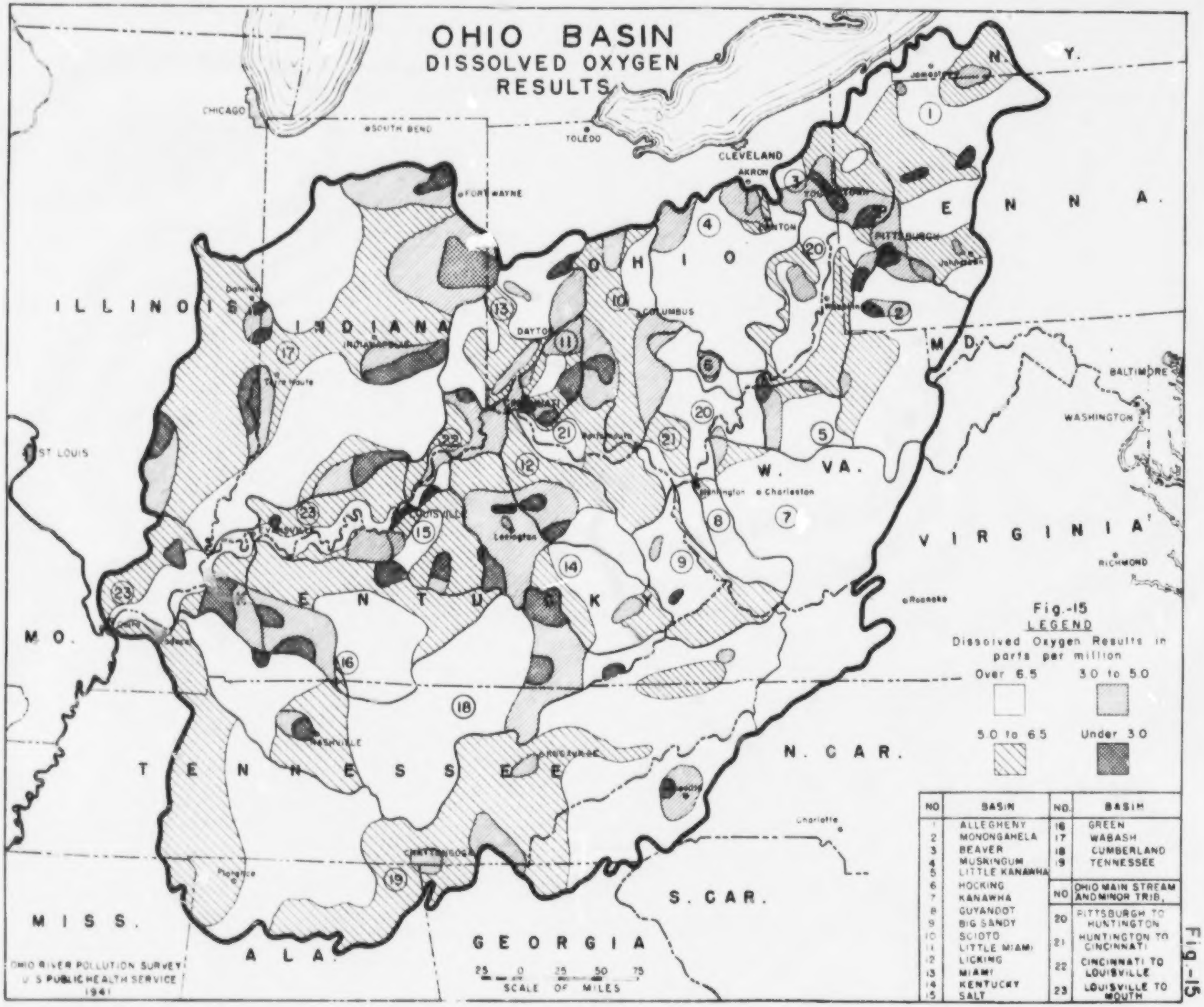
NO	BASIN	NO	BASIN
1	ALLEGHENY	16	GREEN
2	MONONGAHELA	17	WABASH
3	BEAVER	18	CUMBERLAND
4	MUSKINGUM	19	TENNESSEE
5	LITTLE KANAWHA		
6	HOCKING	NO	OHIO MAIN STREAM AND MINOR TRIB.
7	KANAWHA		
8	GUYANDOT	20	PITTSBURGH TO HUNTINGTON
9	BIG SANDY		
10	SCIOTO	21	HUNTINGTON TO CINCINNATI
11	LITTLE MIAMI		
12	LICKING	22	CINCINNATI TO LOUISVILLE
13	MIAMI		
14	KENTUCKY	23	LOUISVILLE TO MOUTH
15	SALT		

Fig -13

Fig.-14


OHIO BASIN
BIOCHEMICAL OXYGEN
DEMAND RESULTS
Fig. – 14
LEGEND
5 Day Biochemical Oxygen Demand in parts per million
Under 3.0
3.0 to 5.0
Over 5.0
NO BASIN
1 ALLEGHENY
2 MONONGAHELA
3 BEAVER
4 MUSKINGUM
5 LITTLE KANAWHA
6 HOCKING
7 KANAWHA
8 GUYANDOT
9 BIG SANDY
10 SCIOTO
11 LITTLE MIAMI
12 LICKING
13 MIAMI
14 KENTUCKY
15 SALT
16 GREEN
17 WABASH
18 CUMBERLAND
19 TENNESSEE
NO OHIO MAIN STREAM AND MINOR TRIB.
20 PITTSBURGH TO HUNTINGTON
21 HUNTINGTON TO CINCINNATI
22 CINCINNATI TO LOUISVILLE
23 LOUISVILLE TO MOUTH
ILLINOIS
INDIANA
OHIO
PENNA
N. Y.
MD.
W. VA.
VIRGINIA
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
MO.
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
AKRON
YOUNGSTOWN
PITTSBURGH
Jamestown
Johnstown
Wheeling
FORT WAYNE
COLUMBUS
Portsmouth
Huntington
Charleston
BALTIMORE
WASHINGTON
RICHMOND
Roanoke
ST. LOUIS
EVANSVILLE
LOUISVILLE
Lexington
Cairo
Paducah
NASHVILLE
KNOXVILLE
Asheville
Charlotte
CHATTANOOGA
Florence
25 0 25 50 75
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941


OHIO BASIN
DISSOLVED OXYGEN
RESULTS
N. Y.
PENNA.
OHIO
INDIANA
ILLINOIS
W. VA.
VIRGINIA
MD.
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
MO.
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
AKRON
CANTON
FORT WAYNE
COLUMBUS
DAYTON
CINCINNATI
PITTSBURGH
Johnstown
Jamestown
BALTIMORE
WASHINGTON
RICHMOND
Roanoke
Huntington
Charleston
Lexington
LOUISVILLE
INDIANAPOLIS
Terre Haute
Danville
ST LOUIS
Nashville
Knoxville
Chattanooga
Charlotte
Florence
1
2
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6
7
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10
11
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16
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19
20
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22
23
25 0 25 50 75
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
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Fig.-15
LEGEND
Dissolved Oxygen Results in parts per million

- ☐ Over 6.5
- ▨ 3.0 to 5.0
- ▧ 5.0 to 6.5
- ■ Under 3.0

NO	BASIN
1	ALLEGHENY
2	MONONGAHELA
3	BEAVER
4	MUSKINGUM
5	LITTLE KANAWHA
6	HOCKING
7	KANAWHA
8	GUYANDOT
9	BIG SANDY
10	SCIOTO
11	LITTLE MIAMI
12	LICKING
13	MIAMI
14	KENTUCKY
15	SALT

NO.	BASIN
16	GREEN
17	WABASH
18	CUMBERLAND
19	TENNESSEE

NO	OHIO MAIN STREAM AND MINOR TRIB.
20	PITTSBURGH TO HUNTINGTON
21	HUNTINGTON TO CINCINNATI
22	CINCINNATI TO LOUISVILLE
23	LOUISVILLE TO MOUTH

Fig.-15

Table 5 Ohio Basin - Number and Percentage of Sampling Stations Showing Worst Monthly Average Coliform and B.O.D. Results within Designated Ranges.

Basin		NUMBER OF STATIONS						PERCENTAGE OF STATIONS					
		Coliform Organisms per ml.			B.C.D. in p. p. m.			Coliform Organisms per ml.			B.O.D. in p. p. m.		
		0-50	51-200	Over 200	0-3	3.1-5.0	Over 5	0-50	51-200	Over 200	0-3	3.1-5.0	Over 5
Allegheny	(a)	73	4	2	59	16	4	92	5	3	75	20	5
	(b)	91	30	38	121	15	23	57	19	24	76	9	15
		164	34	40	180	31	27	69	14	17	76	13	11
Monongahela	(a)	48	7	10	45	2	18	74	11	15	69	3	28
	(b)	29	20	44	70	6	17	31	22	47	75	7	19
		77	27	54	115	8	35	49	17	34	73	5	22
Muskingum	(a)	2	2	1	5	0	0	40	40	20	100	0	0
	(b)	33	33	42	86	9	13	31	31	38	80	8	12
		35	35	43	91	9	13	31	31	38	80	8	12
Hocking	(a)	5	1	3	4	3	2	56	11	33	45	33	22
	(b)	6	3	9	6	3	9	33	17	50	33	17	50
		11	4	12	10	6	11	41	15	44	37	22	41
Kanawha	(a)	6	1	1	6	1	1	75	12	13	75	12	13
	(b)	74	26	42	106	16	20	52	18	30	75	11	14
		80	27	43	112	17	21	53	18	28	75	11	14
Beaver		21	15	29	35	13	17	32	23	45	54	20	26
Little Kanawha		0	5	5	7	1	2	0	50	50	70	10	20
Guyandot		16	5	7	17	6	5	57	18	25	61	21	18
Big Sandy		33	18	37	64	10	14	38	20	42	73	11	16
Scioto		32	15	38	37	17	30	38	17	45	44	20	36
Little Miami		5	2	28	6	11	18	14	6	80	17	31	52
Licking		24	7	3	19	13	12	71	21	8	43	30	27
Miami		12	18	37	21	29	29	18	27	55	26	37	37
Kentucky		32	20	29	52	11	18	39	25	36	64	14	22
Salt		12	4	9	9	6	10	48	16	36	36	24	40
Green		31	1	14	36	0	10	67	2	31	78	0	22
Wabash		102	46	122	94	62	114	38	17	45	35	23	42
Cumberland		45	27	39	73	19	18	41	24	35	66	17	17
Tennessee		55	33	61	97	17	36	37	22	41	65	11	24
Tributary Totals		787	343	650	1,075	286	440	44	19	37	60	16	24
Ohio R. and Minor Tributaries													
Pittsburgh - Huntington		23	43	36	72	7	23	23	42	35	70	7	23
Huntington - Cincinnati		6	8	14	21	4	3	22	28	50	75	14	11
Cincinnati - Louisville		4	9	20	10	14	9	12	27	61	30	43	27
Louisville - Mouth		31	20	23	47	11	14	42	27	31	66	15	19
Ohio River Total		64	80	93	150	36	49	27	34	39	64	15	21

(a) Acid streams. (b) Normal streams.

within portions of the Allegheny and Monongahela basins, affected by acid mine drainage, the lightly shaded areas indicate stream zones in which good sanitary conditions were found, resulting largely from a relatively low degree of pollution. Except in the Muskingum, Green and Wabash basins, these areas are located mostly near the outer edges of each tributary basin in their headwater sections. They include several areas in which recreational use of streams either is being practiced or readily can be developed, notably in the southern portions of the basin. They also include areas offering either actual or potentially desirable sources of water supply.

Areas in which the highest average numbers of coliform organisms exceeded 200 per ml. include the larger sources of pollution and numerous local zones of smaller streams affected by the discharge of untreated sewage. The effects of industrial wastes probably are not shown to any considerable extent on this diagram, as the coliform bacteria is definitely specific as an index of sewage pollution. It is noteworthy, however, that the general locations and extent of these areas reflect to some degree the effects of combined sewage and industrial pollution, as the larger sources of sewage tend to coincide with those of industrial wastes.

Biochemical Oxygen Demand - On Figure 14 the basin has been divided into areas on the basis of biochemical oxygen demand, the darkest shading representing average amounts of B.O.D. exceeding 5 p.p.m., the next heaviest areas those in which the average ranged from 3 to 5 p.p.m., and the unshaded areas representing points where the highest average B.O.D. observed was less than 3 p.p.m.

In general, the heavily shaded areas showing B.O.D. results in excess of 3 p.p.m. tend to coincide fairly closely with those in Figure 13 showing coliform organisms over 200 per ml., though they are somewhat more restricted in their extent in some portions of the map. As the B.O.D. of stream waters is affected both by sewage and by certain types of industrial wastes of an organic nature, the areas indicated in Figure 14 probably show most reliably the stream zones in which the effects of combined sewage and industrial pollution are most apparent. The heaviest shaded areas denote those in which the worst conditions were observed and, in general, indicate the zones of relatively high degrees of pollution. Areas in which the average B.O.D. was not greater than 3 p.p.m. tend to coincide with those of Figure 13, though some minor differences are indicated. In general, they represent stream zones in which sanitary conditions are good and, except for acid pollution in certain limited sections, are relatively free of objectionable pollution precluding their use for normal purposes. The fair agreement between these areas tends to confirm the tentative conclusion that stream waters in good sanitary condition should ordinarily show an average B.O.D. not over 3 p.p.m.

Dissolved Oxygen - Figure 15 presents the dissolved oxygen results divided into areas in which the lowest average content of the streams was not less than 6.5 p.p.m.; between 5 and 6.5, between 3 and 5 p.p.m., and less than 3 p.p.m., the latter being indicated by the heavier shading. An average of 6.5 p.p.m., assuming a 5 p.p.m. minimum on any one day, has been suggested as a safe minimum average for the maintenance of native fish life. The greater extent of these areas as compared with the others of this figure probably is due in part to the fact that a considerable number of dissolved oxygen observations were made during the colder months, when organic decomposition in the stream was retarded and dissolved oxygen levels were higher than they would be expected to be under summer conditions. Because of this, Figure 15 probably shows a more optimistic picture in this respect than would be justified by observations carried out over the entire basin under summer low-water conditions.

Although the heavily shaded areas are less in extent than those on Figure 14, probably owing to the limitations in the proportion of summer observations previously noted, they tend to coincide with, or to be included within, the areas of relatively high B.O.D. results, thus confining within their limitations the locations of the more densely polluted streams in the basin.

LOW-FLOW REGULATION

The stream flows of the Ohio Basin vary greatly. The minimum flow of the Ohio River at its mouth is about eight percent of the average flow and on most of the tributaries the variations are much greater. Since the amount of water available for dilution of wastes is one of the most important factors influencing the degree of pollution, any measures which increase the minimum flow of the streams also aid in abating pollution. Reservoirs for the storage and regulated release of natural stream waters offer the only generally practical means of low-flow regulation in this area.

Untreated municipal sewage may cause nuisance conditions even though the flow of the receiving stream is quite large because of floating solids, scum, grease and the settling and subsequent decomposition of part of the suspended matter with accompanying odors. Hence, low-flow regulation is not a substitute for sewage treatment but an effective supplement which can be used to eliminate the need for more than primary treatment and to improve stream quality where satisfactory complete treatment methods are not available at present.

Where reservoirs expressly for low-flow regulations are proposed to replace secondary treatment, their value can be determined by the cost of the treatment eliminated. Studies of low-flow requirements and sewage treatment cost data indicate that reservoir storage capacity must be provided for not more than $15 per acre-foot if the substitution of low-flow control is to be economically justified. Experience in the Ohio Basin indicates that reservoir capacity seldom can be provided for this amount, particularly in the relatively small amounts usually required for pollution abatement. Therefore, as a general rule, low-flow regulation does not afford an economical substitute for secondary waste treatment.

If more than one source of pollution is benefited appreciably by the flow regulation, the justifiable expenditure may be increased. Thus, if by the construction of a reservoir for flow regulation, the need for secondary treatment at two, three or more downstream places can be eliminated the allowable expenditure for storage may be increased proportionately.

Low-flow regulation can be used to reduce the maximum acidity of streams affected by acid mine drainage. It would not affect the total acid load but could reduce the damage done by acid streams. Studies of the comparative cost of mine sealing and flow regulation indicate that the allowable expenditure for storage to replace mine sealing is from about $0.50 to $2.25 per acre-foot depending on the alkalinity of the stored water (1). Consequently, low-flow regulation cannot economically be substituted for mine sealing but it can effectively supplement it in many instances, particularly in reducing acid surges after the mine sealing program is completed.

Low-flow regulation may also afford an effective means of reducing organic pollution by industrial wastes which cannot at present be adequately controlled by treatment at reasonable cost. The economic feasibility of such control cannot be discussed in general terms.

In addition to its value for abatement of pollution low-flow regulation may be used to insure the adequacy of municipal and industrial water supplies, to improve the navigability of streams and to enhance their recreational value, and to increase the production of hydroelectric plants. Most of the reservoirs that have been constructed for low-flow regulation have been built primarily for one or more of these purposes rather than for pollution abatement.

It is apparent from these data that, in general, low-flow regulation by reservoirs built expressly for pollution abatement is not economically justified, although it may be in some cases. However, if the supplemental low flow can be provided incidental to some other major reservoir use in a multiple-purpose reservoir, the cost of the additional flow may be small enough to warrant inclusion of provisions for low-flow regulation in the reservoir plan. The major purposes for which reservoirs are being built or proposed in the Ohio Basin are flood control and power.

Flood-control reservoirs ordinarily remain empty or nearly so until a flood threatens and are emptied as quickly as practicable after danger has passed in order to make the storage capacity available for the next flood. Studies by the U. S. Engineer Department of the seasonal occurrence of Ohio River floods show that major floods occur during the late winter and early spring. The following table indicates the monthly distribution of damage from Ohio River floods at Pittsburgh.

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(1) Alkalinity assumed to vary from 10 to 40 p.p.m.

Table 6 Monthly Distribution of Damage from Ohio River Floods at Pittsburgh, Pa.

Month	Average Flood Damage as Percent of Damage in Maximum Month	Month	Average Flood Damage as Percent of Damage in Maximum Month
January	22	July	1
February	32	August	1
March	100	September	6
April	12	October	1
May	2	November	2
June	2	December	3

The markedly seasonal character of Ohio River floods and the equally seasonal character of low-flow occurrences suggest the possibility of using a portion of the capacity of the flood-control reservoirs after the end of the flood season for storage of water to be released during the late summer and early fall months when stream flow is usually lowest. The U. S. Engineer Department has investigated the practicability of such operations and found that at many of the proposed and existing flood-control reservoirs in the Ohio Basin as much as one-third of the flood-storage capacity can be used for low-flow regulation from April 15th to December 1st without appreciably reducing the degree of flood protection. In reservoirs whose capacities are limited to less than the amount necessary for control of the major floods such encroachment on the flood-storage capacity is not considered feasible.

Hydroelectric reservoirs usually store water during periods of high stream flow and release it during dry periods. The amount of water released is usually dependent on the power demand. Low-flow regulation for other purposes can often be included in the program of reservoir operation without interfering greatly with power production.

The possibility of using existing or proposed reservoirs in the Ohio Basin for low-flow regulation has been considered and discussions of various projects are included in the Basin Summaries and in the section of the report on Acid Mine Drainage. A number of areas have been found where low-flow regulation could be of considerable value for pollution abatement and water supply.

ADMINISTRATION OF POLLUTION ABATEMENT

Stream pollution is a problem of national concern. Responsibility for its abatement is primarily local. Power to require its abatement rests with the states, the Federal government having little authority in this field. All of the states have adopted laws of some kind for the purpose of controlling pollution, and, in addition, the common law affords remedies to injured parties. Because the problem is technical and one requiring constant attention, the states have delegated power to administer the laws to some state agency, usually the health agency, since the protection of the public health is usually the primary purpose of pollution abatement. The progress that has been made varies from state to state. A survey of state laws, their administration, and the organization of the administrative agencies has been made to determine what effect laws and their administration have had on the progress of pollution abatement and to determine what steps might be taken to accelerate progress.

This survey indicates that more important than a stringent antipollution law is the existence of an adequately staffed agency carrying on an effective educational and promotional program. Education, with its concurrent awakening of the public consciousness to the value of clean streams and promotion of remedial works' installation are the foundations of a stream sanitation campaign. A campaign based upon these two factors will attain a substantial measure of success without the legal authority necessary to require the installation of remedial works. However, an impasse is finally reached when the authority must be employed if the program is to proceed.

The law should centralize authority over stream pollution in one state agency, authorized and qualified to consider the effects of pollution on all water uses, and not limited to its effects on the public health. No type of wastes and no area should be excepted from the provisions of the law. The agency should be delegated power to function administratively and to enforce the law without the continual necessity of time-consuming court action. It should be given the power to define pollution and the power to seek injunctions when necessary to protect the public interest. It should be permitted to carry out fact finding investigations relative to pollution. Findings of fact are essential in all actions, particularly in case of court review. The agency should be permitted to prepare a program for pollution abatement and should have authority to require proper operation of remedial works.

Legal restrictions on the bonding or taxing power of municipal corporations have deterred the installation of sewage treatment works. Provisions for financing these works by revenue bonds and sewer rental charges have aided greatly in overcoming these restrictions. The state administrative agency should be given the power to require municipalities to utilize all means at their disposal to finance the construction of treatment works that have been found by the agency to be necessary. Provision should be made for the formation of sanitary districts to construct and operate treatment works.

In none of the states in the Ohio Basin are all of the above provisions in effect. Outstanding defects are the exemptions of acid mine drainage from control in Pennsylvania, West Virginia and Ohio and the lack of authority of Ohio, Indiana and Illinois over wastes from Ohio River communities.

Organization

In several of the states surveyed, more than one state agency is empowered to enforce pollution abatement laws. A comparison of the ease and efficiency of operation in these states with that in other states with centralized control clearly indicates the advisability of the latter method. In this manner, responsibility is centralized and complete coverage of the problem without duplication of effort can be assured at a minimum of expense.

There is an increasing tendency to view pollution abatement in its broad perspective; namely, as an effort to promote the full utilization of a vital natural resource. For this reason it is necessary that the administrative agency not limit its activities solely to pollution affecting the public health or interfering with fish life. It should be permitted by law and qualified technically to act against pollution affecting any phase of water use. The type of organization best suited to do this cannot be stated categorically.

A number of states in the Ohio Basin and elsewhere have placed authority in a sanitary water board, a state water commission or some similar agency. Such a body includes representatives of all official agencies concerned with water pollution and occasionally representatives of industry and sportsmen. In this manner all interested parties are given a voice in the establishment of policies and feelings of animosity so often present are minimized.

Another method of achieving the desired co-ordination is by the establishment of an advisory board. This scheme has not been adopted in any of the states in the Ohio Basin but it has been suggested by a number of authorities. Administration would be centered in one existing agency already vested with authority. This agency would be advised as to policies and procedures by a commission including officials of state agencies concerned with water problems and representatives of industry and sportsmen. The commission may be supplemented by local watershed advisory boards throughout the state consisting of representative citizens interested in local improvement and good stream sanitation.

This type of organization takes from some agencies control which they might otherwise have and substitutes merely advisory authority. Unless a high state of interest is maintained, something which is difficult of attainment in this particular field, the interest of the advisory committee is apt to lag and its influence diminish or entirely disappear. Whether or not such a scheme would be successful would depend to a very large degree upon the executive and organizing ability, personality and farsightedness of the head of the enforcement agency.

The most common practice is to make the state health agency the administrative agency for pollution abatement laws. The sanitary engineering divisions of these agencies are usually the ones most actively engaged in pollution abatement work and are better qualified technically than any other one agency to carry on such activities. The protection of water supplies from pollution is of definite concern to the health department. The effects of pollution on streams used for recreation are also of interest to the health agency. In practically all states the health department has been delegated authority either to supervise pollution abatement work or to advise cities and industries with reference to their waste disposal problems. By virtue of their functions and experience, state health agencies should have considerable authority in any organization for the administration of pollution abatement. In most sanitary water boards, the state sanitary engineer is executive secretary of the board and the most active individual member. Under the advisory board scheme, the health agency is usually the administrative agency. In those cases where there is no legal provision for co-ordination of the views of all interested agencies and parties and the health agency alone is given authority, the co-ordination can be achieved unofficially if the agencies and individuals concerned are not unduly jealous of their positions, prerogatives and programs.

In short, the exact type of organization is not highly significant. It is much more important that the agency be adequately financed and properly staffed with trained men familiar with pollution problems and their relation to all phases of water use. Personality and enthusiasm are as important as technical ability. The agency must be able to carry on an effective educational and promotional program and to work without friction with municipal and industrial officials. A minority of recalcitrant individuals and officials can be dealt with by legal action but effective policing to enforce an unpopular law would require so many men that the entire scheme would be impractical.

Authority

In some instances co-operation can be obtained only if there is some legal power or authority which might be used. In other instances actual use of authority is necessary. The state administrative agency should have the following powers:

(a) Power to define what constitutes pollution, with the definition based on consideration of all phases of water use.

(b) Authority to investigate pollution on its own initiative. Investigation of all complaints to the agency should be mandatory.

(c) Power to review all sewerage plans and plans for new industrial waste outlets and to require suitable treatment.

(d) Power to issue orders against polluters, requiring abatement of pollution.

(e) Power to seek injunctions when necessary to protect the public interest.

(f) Control over the operation of remedial works.

All of these powers are designed to promote rapid and efficient solution of the problem with a minimum of litigation. The actions of the agency would be subject to court review as are the actions of any other administrative agency.

The basic law may well define pollution in general terms but the agency should be given the power to define in more precise terms what will be considered actionable pollution.

The definition should be broad enough to include pollution which would interfere unduly with any water use and definite enough to enable municipalities and industries to determine what may be expected of them. No exceptions should be made in the basic law as to either areas or types of wastes subject to the control of the administrative agency but the agency should not be required to apply a uniform standard of quality to all streams in the state or to all wastes of a given type.

The agency should be permitted to make all fact-finding surveys and investigations. Findings of fact are highly important, not only to serve as a basis for recommendations and orders but also to support the agency in possible cases of court review. These surveys and investigations should be permitted without having to wait for a complaint. The agency should be given the right of access to municipal and private property necessary to make surveys and investigations. Only in this way can a comprehensive plan and program be developed. The requirement that all complaints must be investigated and reported on is a valuable aid in securing public approval of the program.

The power of review of all plans for new work involving increases in waste discharges enables the agency to prevent any important increases in pollution while engaged in its programs of abatement of pollution from existing sources. To make this power effective, the agency should be able to make rules and regulations governing sewerage and industrial waste treatment. Most of the states with effective pollution abatement programs have given this power of review to the administrative agency.

The power to issue orders requiring the abatement of pollution has been an extremely valuable instrument in many states. The basic law should outline the procedure to be followed in issuing such orders and provide for the enforcement of them. In general, the procedure is as follows:

(a) The agency makes an investigation to determine whether or not actionable pollution exists.

(b) If such pollution is found to exist the offender is cited to appear before the agency for a hearing and show cause why an order should not be issued requiring the abatement of the pollution.

(c) If the offender cannot show sufficient cause, an order is entered requiring the treatment or complete elimination of the waste discharge causing pollution.

This procedure is much more economical of time and money, and requires less litigation than if the agency were required to seek action through other legal channels.

Occasionally, even this type of machinery is too slow to protect properly the public interest. This is particularly true in the case of seasonal industries, when ponded wastes are suddenly discharged, or when remedial devices are improperly operated. The agency should be able to take action by injunction or otherwise to prevent such pollution.

To ensure the proper operation of treatment plants and other remedial works, the state administrative agency should be empowered to supervise their operation and to make the necessary rules and regulations. The agency should be adequately and properly staffed to permit it to assist municipalities and industries in the solution of operating problems.

Sanitary Districts

Legislation to allow the easy formation of sanitary districts to serve unincorporated areas or combinations of one or more municipalities and adjoining areas is necessary if one of the more troublesome and difficult to control pollution sources, the private sewer, is to be eliminated and if pollution abatement work is to be carried on most economically and effectively in metropolitan areas. Most states have made some provision for such districts but, in many instances, the formation and preliminary financing have been made so difficult that the law is seldom used. In one state, 90 percent of the property owners concerned must sign the petition for the district's formation. Illinois has used the sanitary district method with considerable success. Reasonable legislation could facilitate the formation of districts and still protect against the formation of additional unnecessary governmental units.

The administrative agency may well be given power to review plans for the formation of districts and the power to order the formation of districts where this appears to be the only feasible solution to a pollution problem, as in the case of unincorporated areas on the fringes of municipalities. Ohio's administrative agency has this authority with reference to county sewer districts and the program in the state has been materially assisted by the authority. In most other states individual prosecution, a cumbersome device at best, must be either used or threatened to accomplish district formation in such cases.

Financing

Constitutional and statutory limitations on the bonding and taxing power of cities have hindered the installation of remedial works in many instances. If a pollution abatement program is to proceed some means must be found, consistent with sound financial policy, to overcome these difficulties. The principle of allowing municipalities to exceed these limitations upon order of the administrative agency might be applied to statutory limitations but where the limitations are imposed by the constitution, this would probably not be feasible. In some states the municipalities are forbidden to issue bonds for other purposes so long as a state order requiring the installation of pollution abatement works has not been complied with. Provision may also be made for revenue financing of sewage works, permitting the assessment of sewer service charges. This is an equitable method of financing such works and has been used in a large number of cases in recent years. A recent adverse Pennsylvania court decision in the case of Philadelphia, which is up to its debt limit, ruled against determining sewer rental charges on the basis of the assessed valuation but at the same time stated that a charge based on a proportion of the water charge was proper.

Administrative Policies

In investigating the administration of pollution abatement, a number of policies were encountered which have met with a great deal of success. In general, it was found that the agencies which have been most successful have been relatively slow to use the courts or administrative orders to force action. Much of their effort has been devoted to arousing public consciousness of the value of clean streams and securing public support for remedial measures. They try to co-operate and consult with municipalities and industries in order to work out the most satisfactory solution of individual problems.

A practically universal policy at the present time in the Ohio Basin is that no new sewers may be installed unless treatment is provided. Some states even require that no additions may be made to existing sewer systems without provision for treatment. The Works Progress Administration has aided in effectuating such policies by refusing to approve sewerage projects without treatment except in special cases.

Another policy that has been helpful in hastening progress is that of informing injured riparian owners of their rights. The technical knowledge of the enforcement agency can be of great value to the individual owners who seldom have the means of getting the necessary information for the successful prosecution of a lawsuit.

Much of the routine work of the state administrative agencies is concerned with securing proper operation of remedial works after they have been installed. The common tendency to consider the problem as solved once the treatment plant has been constructed must be combatted continually. The agency must be adequately staffed to permit the frequent inspection of remedial works and to aid plant operators in solving their problems. Most states have adopted the policy of requiring submission of rather complete records of plant operation. Some states offer prizes to those operators submitting the best records.

In order to stimulate interest in the problems of plant operation and to improve the standards of operation, a number of states have conducted or sponsored short schools and conferences for operators. Most of the operators of the smaller plants have little or no technical education and these schools have been instrumental in giving such men an understanding of the scientific principles underlying efficient plant operation. In addition, such schools enable the men to meet each other, to discuss their common problems and exchange experiences.

Another step that has been taken to improve the caliber of plant operators is the licensing of operators by the state administrative agency. As a rule, the licensing plan operates similarly to licensing of stationary engineers with several grades of licenses and requirements as to education and experience, as well as an examination. Licensing has been helpful in improving the tenure of competent operators and in attracting better trained men to such jobs.

Interstate Waters

As in the case of other water problems, the difficulty of dealing with pollution of interstate streams has cast doubts on the effectiveness of state control and brought forth demands for Federal action. Progress has been made in certain areas in the solution of some interstate pollution problems but, in general, much less has been done than where the problems were primarily intrastate and subject to the control of a single agency. The Ohio River is a striking example of this.

Informal interstate agreements have been effective in reducing tastes and odors in Ohio River water supplies but no appreciable progress has been made in reducing sewage pollution of the river. Much of the difficulty is due to the lack of jurisdiction of the states north of the river over the stream.

The Ohio River Valley Water Sanitation Compact has been drafted by compact commissioners of the states involved, approved by the Congress, and ratified by four of the state legislatures (Indiana, New York, Illinois and Kentucky) unconditionally. The Ohio and West Virginia legislatures have ratified the compact but their action does not become effective until the Pennsylvania legislature also ratifies. Considerable progress has been made in Pennsylvania toward ratification of the Compact, one branch of the legislature having passed ratification legislation on two occasions.

The personnel of the Ohio River Valley Compact Commission that drafted the Compact is of particular interest. Represented on this Commission were the administrative or technical heads of the pollution administrative agencies of the states bordering on the Ohio River. These representatives had been engaged in administering pollution control laws for a great many years and some of the most notably successful pollution control programs of this country have been due to their efforts. The compact, as finally approved, represents the concensus of these successful, experienced administrators in their efforts to prepare a practical workable document. An outline of the provisions of the compact is included in the summary dealing with the main Ohio River.

Two interstate compacts dealing with water pollution have been in effect for several years. The one between New York and New Jersey dealing with the problems of the metropolitan area of New York has been fairly successful. The one between North Dakota, South Dakota and Minnesota on the Red River of the North has accomplished little. A third, the Potomac Compact, adopted by Maryland, Virginia, West Virginia and the District of Columbia created the Potomac Valley Conservancy District, organized formally in October, 1941. Activities to date have been confined to a preliminary assembling of available data. The formation of these compacts may be taken to indicate a trend but none of them are sufficiently comparable to serve as a basis for predicting the success of this method in the Ohio valley as a means of abating water pollution.

Progress has been made in pollution abatement in the Delaware River Basin since the establishment of the Interstate Commission on the Delaware (Incodel) in 1936. This Commission derives its authority from Joint Legislative Commissions on Interstate Cooperation established by the four states of the basin. No interstate compact is involved. Standards of quality for effluents discharged to various zones of the basin have been agreed upon by the four states and a general plan drawn up for treatment of municipal wastes. Progress has also been made in construction of sewage treatment works. Financial difficulties have deterred construction of such works at Philadelphia, the key to the solution of the water pollution problem of the basin.

Most interstate compacts in the past have dealt with matters which once settled require little further attention, such as boundary disputes. Compacts have been fairly successful in settling matters of the apportionment of water in interstate streams in the sections of the country where irrigation is important. The Chio River Valley Water Sanitation Compact is the first to be negotiated dealing with a continuing and complex problem in a large area and its success or failure will probably have considerable influence on future attempts at controlling pollution of interstate waters. It is highly desirable that the compact be ratified.

Federal Interest

The increasing activity of the Federal government in other fields of water use and control, together with the lack of progress being made in the solution of interstate pollution problems in some areas have been responsible for a number of proposals of Federal legislation on the subject. The proposals have been of two general types; one providing for Federal, technical and financial aid to states and administrative agencies and financial aid to municipalities and industries in the construction of pollution abatement works; the other providing for similar aid to municipalities and industries and, in addition, for Federal control over the pollution of interstate waters. The need for financial assistance if the work is to proceed rapidly has been shown by the effect of Federal aid on the rate of progress of sewage treatment in recent years and is generally recognized. The need for Federal exercise of police power, however, has been bitterly contested. The disagreement is not one that can be resolved by findings of act at the present time. It involves problems of governmental policy not within the scope of this survey. The findings of this survey do indicate a need for something more than the present degree of control over pollution of the Ohio River. The compact provides a method for this control, through the utilization of existing, experienced state agencies working together with Federal assistance. Whether or not this method is efficient and effective can be decided only after a trial.

The Federal government can encourage such efforts by making available advisory and technical assistance. The present survey should provide the basis for a program of control when and if the Ohio River Compact becomes effective.

ACID MINE DRAINAGE STUDIES

Acid drainage from coal mines affects the streams throughout the area covered by the Ohio River Basin coal fields, (see Figure 3). In Pennsylvania and West Virginia, the two largest bituminous coal producing states, the problem dominates the stream sanitation picture. The present situation exists despite the fact that in these two states only 5.1 percent of the coal deposit has been mined out or lost. The present survey has conducted a study of the basic theories of acid formation in coal mines and the possibilities and experience with remedial measures. Particular attention has been directed to control meqsures involving mine sealing and flow regulation, particularly by multiple purpose use of flood-control and other purpose reservoirs. Studies and demonstrations by the U. S. Bureau of Mines of the possible accomplishments of mine sealing have shown that acid control at the mine is practical at reasonable cost, and a start, made in the form of a Works Progress Administration program (see Figure 16) of sealing abandoned mines with U. S. Public Health Service and state co-operation, has confirmed (see Figure 17) the earlier work. The present sealing program, however, is not a continuing activity having been discontinued from time to time in some states. Provision for essential maintenance is lacking. Flow regulation by flood-control reservoirs built by the U. S. Engineer Department has had a beneficial effect. Aggressive prosecution of a suggested remedial program is amply justified, particularly in the Pittsburgh District where tangible monetary benefits can be shown in excess of remedial costs. Remedial measures are imperative to insure the future of the principal streams in the mining areas.

The question of acid mine drainage has been made the subject of a detailed supplement to this report and consideration here is confined to summarized information and conclusions.

Acid Load Reduction by Sealing

Mine acid loads in the major tributaries of the Ohio River Basin as originally measured and after present sealing and suggested sealing under 1940 restrictions are given on Figure 16 and Table 7. Total basin acid loads from this table and the estimated load following a sealing program with 1940 restrictions modified are as follows:

Original mine acid load	2,500,000	tons	per	year
Reduction, to date, by sealing	700,000	"	"	"
Present mine acid load	1,800,000	"	"	"
Possible further reduction by sealing under 1940 restrictions	600,000	"	"	"
Load after sealing under 1940 restrictions	1,200,000	"	"	"
Possible further reduction with 1940 restrictions modified	600,000	"	"	"
Estimated ultimate residual load	600,000	"	"	"

The sealing program under 1940 restrictions is based on a cost limitation of $10.00 per ton of acid per year and sealing only in areas not connected to active ventilation systems. Modified restrictions would permit sealing operations in worked-out sections of active mines.

The cost and benefit estimates, discussed later, apply to work necessary to complete a sealing program under 1940 restrictions and the report discusses this completion as a first objective.

Free mineral acid from waste pickle liquor is estimated at 3.4 percent of the present total free and combined mine acid load. Acid from hydrolized iron sulphates may be minor or as high as 10 times this quantity depending on the hydrolysis equilibrium.

Mine Sealing Costs

Mine sealing costs to date in the Ohio River Basin, as shown in Table 8, have been about $5,400,000. To complete a sealing program under 1940 restrictions will cost an estimated additional $5,500,000. Annual charges of interest (3½%), amortization (0.7% based on 3½% interest and a 50-year life), inspection (2%) and maintenance (7 to 10%) are about 15 percent or $1,635,000 on the total of these two sums of $10,900,000. This is about 4 mills per net ton of production and confirms an estimate of the Office of Mine Sealing, U. S. Public Health Service. These and other estimates of future mine sealing costs are believed conservatively high as they are based primarily on past experience with Works Progress Administration programs with the dual purpose of providing relief and improving mine acid conditions.

Fig. -16

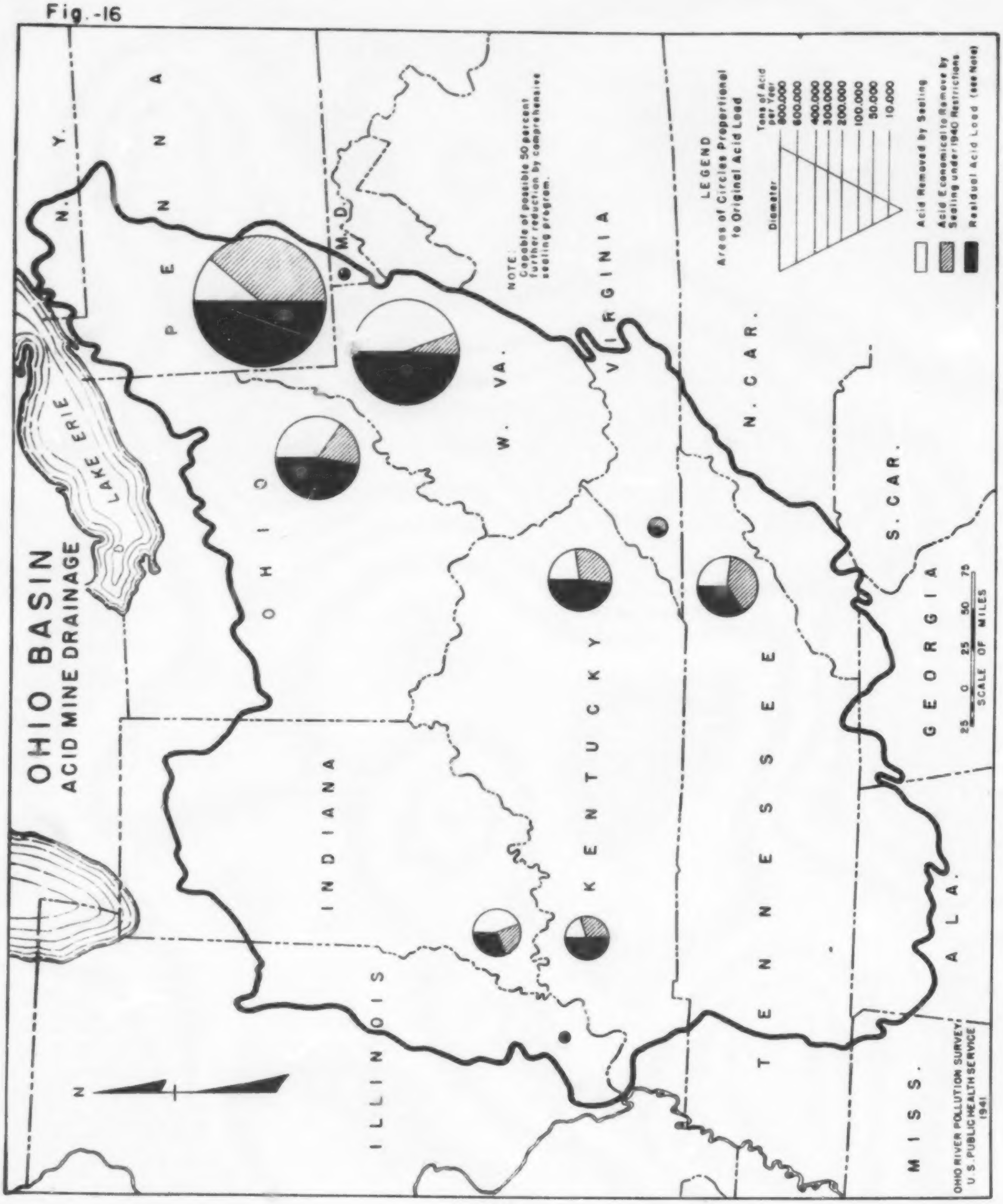

OHIO BASIN
ACID MINE DRAINAGE
LAKE ERIE
N. Y.
PENNA
M. D.
OHIO
W. VA.
VIRGINIA
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
N. CAR.
S. CAR.
GEORGIA
ALA.
MISS.
N
NOTE:
Capable of possible 50 percent further reduction by comprehensive sealing program.
LEGEND
Areas of Circles Proportional to Original Acid Load
Diameter
Tons of Acid per Year
800,000
600,000
400,000
300,000
200,000
100,000
50,000
10,000
Acid Removed by Sealing
Acid Economical to Remove by Sealing under 1940 Restrictions
Residual Acid Load (see Note)
25 0 25 50 75
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Table 7 Acid Mine Drainage - Summary by Tributary Drainage Basins and States of Original Classified Mine Acid Loads, Intensity per Square Mile, Acid Removed by Sealing, Estimated Acid Economical to Remove under 1940 Restrictions and Residual Mine Acid Loads.

Tributary Drainage Basin and State	Drainage Area	Original Acid Load as $CaCO_3$					Sealed Mines		Acid Removed by Sealing	Economical to Remove in Addition By Sealing	Residual Acid Load After Sealing under 1940 Restrictions (2)	
		Active Mines	Marginal (1)Mines	Abandoned Mines	Total Mines		Original Acid Load	Efficiency				
	Square Miles	Tons per Year	Tons per Year	Tons per Year	Tons per Year	Tons per Sq.Mi. per Year	Tons per Year	Percent	Tons per Year		Tons per Year	Percent
Alle. R. except Kiski.	9,838	26,457	6,760	50,244	83,461	8.5	24,040	78	18,750	32,330	32,381	39
Kiskiminetas River	1,892	223,896	23,805	73,988	321,689	170.0	20,270	54	10,954	132,630	178,105	55
Allegheny River Total	11,730	250,353	30,565	124,232	405,150	34.5	44,310	67	29,704	164,960	210,486	52
Monon. except Yough.	5,648	438,274	39,064	223,634	700,972	124.1	380,026	66	251,900	115,630	333,442	48
Youghiogheny River	1,732	141,735	25,609	52,340	219,684	126.8	29,270	78	22,742	83,050	113,892	52
Monongahela R. Total	7,380	580,009	64,673	275,974	920,656	124.7	409,296	67	274,642	198,680	447,334	49
Beaver River	3,145	5,480	988	10,920	17,388	5.5	5,376	42	2,280	6,500	8,608	50
Little Kanawha River	2,320	323	2	493	818	0.4	716	65	470	50	298	36
Kanawha River	12,300	9,210	995	22,650	32,855	2.7	21,157	65	13,750	2,170	16,935	52
Guyandot River	1,670	15,680	614	3,890	20,184	12.1	14,333	65	9,320	1,330	9,543	47
Big Sandy River	4,280	16,236	8,997	35,699	60,932	14.2	26,324	56	14,738	18,320	27,874	46
Muskingum & Hocking R.	9,225	37,700	14,600	163,500	215,800	23.4	170,000	54	91,400	19,000	105,400	49
Scioto River	6,510	4,900	2,400	16,800	24,100	3.7	11,540	54	6,230	7,100	13,770	45
Little Miami River	1,755	0	0	0	0	0	-	-	-	-	0	-
Licking River	3,670	-	-	-	Slight	-	-	-	-	-	0	-
Miami River	5,385	0	0	0	0	0	-	-	-	-	0	-
Kentucky River	6,940	10,900	3,200	27,800	41,900	6.0	22,865	50	11,433	9,520	20,947	50
Salt River	2,890	0	0	0	0	0	-	-	-	-	0	-
Green River	9,220	26,500	7,900	42,100	76,500	8.3	30,230	50	15,115	23,140	38,245	50
Saline River	1,235	-	-	-	Slight	-	-	-	-	-	0	-
Tradewater River	995	3,000	1,500	3,400	7,900	7.9	1,730	50	865	3,270	3,765	48
Cumberland River	18,000	53,610	13,045	198,115	264,770	14.7	106,056	65	68,862	93,070	102,838	39
Tennessee River	40,600	4,960	1,145	32,063	38,168	0.9	20,239	80	16,200	10,770	11,198	29
Wabash River	33,100	26,777	3,174	79,631	109,582	3.3	54,054	87	47,040	30,403	32,139	29
Main Ohio R. - Pa.	1,290	27,380	11,320	10,697	49,397	38.3	14,100	64	9,030	15,050	25,317	51
Ohio	6,450	21,100	7,400	85,000	113,500	17.6	45,820	54	24,750	40,200	48,550	43
W.Va.	3,005	7,579	764	18,464	26,807	8.9	14,028	65	9,120	1,770	15,917	59
Ky.	5,680	4,700	1,300	11,200	17,200	3.0	7,854	50	3,927	4,900	8,373	49
Ind.	3,480	2,978	64	10,013	13,055	3.8	6,964	87	6,060	496	6,499	50
Ill.	1,645	356	1,804	411	2,571	1.6	305	70	214	1,000	1,357	53
Main Ohio River Total	21,550	64,093	22,652	135,785	222,530	10.3	89,071	60	53,101	63,416	106,013	48
Unclassified - Va.	7,175	-	-	-	18,750	2.6	0	-	0	11,070	7,680	41
Total Ohio River Basin	203,900	1,109,731	176,450	1,173,052	2,477,983	12.2	1,026,288	64	655,150	662,769	1,160,064	47
Alabama	6,810	0	0	0	0	0	-	-	-	-	0	-
Georgia	1,490	0	0	0	0	0	-	-	-	-	0	-
Illinois	11,440	356	1,804	411	2,571	0.2	305	70	214	1,000	1,357	53
Indiana	29,135	29,775	3,238	89,644	122,637	4.2	61,018	87	53,100	30,899	38,638	32
Kentucky	39,375	88,900	31,700	180,000	300,600	7.6	129,000	50	64,500	89,500	146,600	49
Maryland	430	535	79	847	1,461	3.4	570	60	342	400	719	49
Mississippi	385	0	0	0	0	0	-	-	-	-	0	-
New York	1,955	0	0	0	0	0	-	-	-	-	0	-
North Carolina	6,260	0	0	0	0	0	-	-	-	-	0	-
Ohio	29,570	65,000	25,000	270,000	360,000	12.2	229,600	54	123,590	68,900	167,510	46
Pennsylvania	15,620	521,513	90,003	277,833	889,349	56.9	128,237	72	91,804	349,560	447,985	50
Tennessee	33,645	25,170	5,190	160,478	190,838	5.7	74,771	80	59,800	72,440	58,598	31
Virginia (Unclassified)	7,175	-	-	-	18,750	2.6	0	-	0	11,070	7,680	41
West Virginia	20,610	378,502	19,436	193,839	591,777	28.7	402,797	65	261,800	39,000	290,977	49
Total	203,900	1,109,731	176,450	1,173,052	2,477,983	12.2	1,026,288	64	655,150	662,769	1,160,064	47

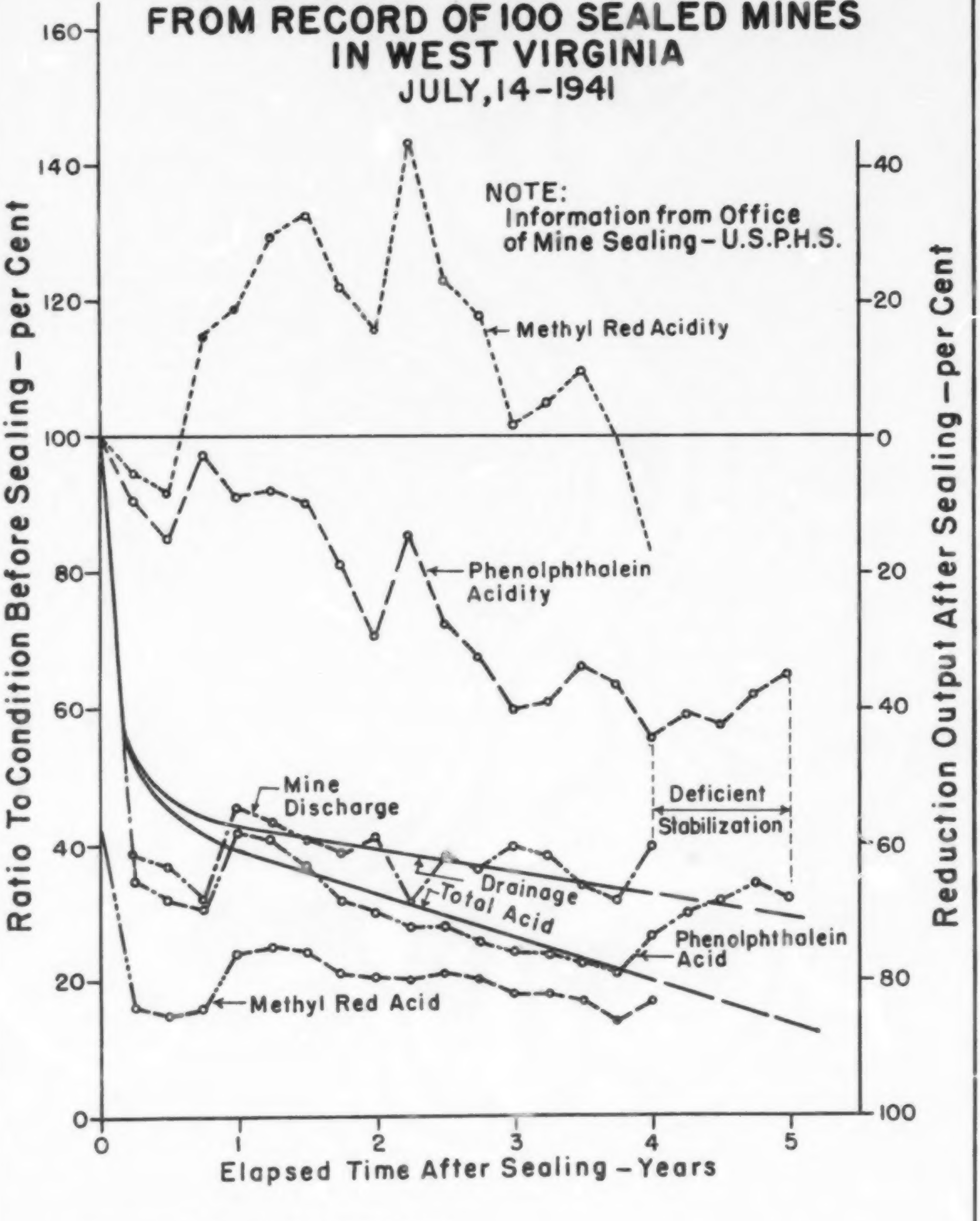
(1) Not completely abandoned.

(2) Areas connected to active ventilation systems and areas where costs exceed $10.00 per ton per year not included.

EXPECTANCY CURVES FOR MINE SEALING PERFORMANCE FROM RECORD OF 100 SEALED MINES IN WEST VIRGINIA

JULY, 14-1941

Fig.-17



NOTE:
Information from Office of Mine Sealing - U.S.P.H.S.

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1942

Table 8 Acid Mine Drainage - Cost of Works Progress Administration Program of Mine Sealing to Date and Estimated to Complete Restricted Mine Sealing Program, both State-wide and for the Ohio River Basin.

State	State-Wide Expenditures			Ohio Basin Expenditures	
	Total to Date (1)	Per Ton Per Yr. of Acid Sealed	Estimated to Complete Program	Estimated Total to (1) Date	Estimated to Complete Program
			By States		
Illinois	$ 12,000	$ 7.26	-	(2)	-
Indiana	273,000	4.48	$ 80,000	$ 270,000	$ 80,000
Kentucky	340,000	2.66	1,200,000	340,000	1,200,000
Maryland	221,000	8.25	50,000	10,000	-
Ohio	1,935,000	8.40	400,000	1,940,000	400,000
Penn.	2,666,000	11.50	4,000,000	1,490,000	3,100,000
Tennessee	109,000	2.46	420,000	110,000	420,000
Virginia	0	-	150,000	0	150,000
W.Virginia	1,462,000	3.00	200,000	1,210,000	160,000
Total	7,018,000	5.80	6,500,000	5,370,000	5,510,000
			By Basins		
Minor Tributary Basins				$ 650,000	$ 480,000
Allegheny				510,000	1,460,000
Monongahela				1,820,000	1,600,000
Beaver				60,000	50,000
Muskingum and Hocking				1,450,000	110,000
Kanawha				70,000	120,000
Guyandot				40,000	10,000
Big Sandy				70,000	240,000
Scioto				100,000	40,000
Kentucky				60,000	130,000
Green				80,000	310,000
Wabash				240,000	80,000
Cumberland				200,000	780,000
Tennessee				20,000	100,000
Total				5,370,000	5,510,000

(1) Rounded. (2) Less than 5,000.

Mine Acid Control Program

Present information indicates that correction, in large measure, of the mine acid pollution problem is practical by a comprehensive control program involving the following measures:

(a) Provisions for the inspection and maintenance of present air seals and a similar provision in connection with all future mine sealing programs.

(b) Completion of the present limited (1940 restrictions) mine sealing program.

(c) Provision of reservoir capacity, presumably in primarily flood-control reservoirs, for flow regulation for acid and organic pollution control.

(d) Inauguration of an aggressive program of mine sealing with present restrictions modified.

(e) Adaptation of the better mining methods to acid control.

(f) Extension of the established practice of refraining from discharging acid waters to streams previously uncontaminated.

(g) Clarification of the laws governing mine drainage to facilitate the corrective program.

Upper Ohio Basin

For illustrative purposes and to indicate cost to benefit relationships, special studies have been made in the upper Ohio River Basin area or the area above the Ohio-West Virginia-Pennsylvania State line. Estimates have been made of accomplishments, costs and benefits resulting from application of the first three of these items, namely, mine sealing, maintenance and flow regulation. Any study of reservoir development should include consideration of organic pollution control and the program studied considers both organic and acid pollution.

Damages - Damages capable of monetary evaluation caused by acid mine drainage include neutralization and softening costs to domestic and industrial water supplies and corrosion of steamboats, barges, power plant condensers and river and harbor structures. These damages in the area above the Ohio-

West Virginia-Pennsylvania State line, totaling about $2,000,000 per year, are shown on Table 9. Equally important, but intangible or unevaluated, damages are to water supply due to manganese, to recreation through the destruction of normal aquatic life, to agricultural uses, to highway structures, to the mines themselves, and indeterminate but serious damages to the public health due to rapid fluctuations in quality as reported by water plant operators. Mine acid is a deterrent to organic pollution abatement as incentive for abatement measures is lacking if the result is a stream suitable only for disposal of mine waters. Mine acid is not a safeguard to public water supplies as the rapid increase in flow during a freshet may bring sufficient alkalinity to neutralize the acidity and eliminate any germicidal effect there may be.

Table 9 Acid Mine Drainage - Summary, as of 1940, of Annual Damages, Capable of Accurate Estimation and Caused by Acid Mine Drainage above the Ohio-West Virginia-Pennsylvania State Line.

		Total Annual Damages
Domestic Water Supplies.		$ 364,000
Industrial Water Supplies.		407,000
Steamboats and Barges.		1,143,000
Power Plants		76,000
River and Harbor Structures.		76,000
Floating Plant (U.S.E.D.).		5,000
Total - 1940		2,071,000
Future Estimate - 1950	Based on estimated future quality but no increase in use	2,630,000
Future Estimate - 1960		$3,190,000

Mine Sealing - Data on mine acid loads before and after various stages of sealing, similar to that given on Table 7, for the upper Ohio River Basin are as follows:

Original mine acid load	1,375,000	Tons per year
Reduction, to date, by sealing	313,000	" " "
Present mine acid load	1,062,000	" " "
Possible further reduction by sealing under 1940 restrictions	379,000	" " "
Load after sealing under 1940 restrictions	683,000	" " "

The completion of a mine sealing program in this area under 1940 restrictions will cost an estimated $3,250,000. Annual charges, including interest, amortization, inspection and maintenance as already enumerated, are 15 percent or $488,000 on this expenditure. Similar annual charges on existing mine seals of 15 percent of the approximately $2,550,000 spent on mine sealing to date in this area are $382,000 per year, making a total of $870,000 per year. As shown on Figure 17, if these existing seals are not maintained, the benefits already realized may easily be lost making it necessary to repeat the expenditure.

Flow Regulation - The application of mine sealing under 1940 restrictions will greatly reduce the maximum monthly acidity but there will still remain acid surges and months in which conditions are unsatisfactory. The acid surges, particularly during times of low flow, will be a hazard to aquatic life. A further improvement during all but the highest flow months and a measure of protection against acid surges hazardous to aquatic life are possible by the application of flow regulation from reservoir storage. The estimated reservoirs selected for acid control are the largest that can be used without storing for periods greater than one year. Utilization of increased capacity beyond this point would be infrequent and the unit value would therefore be reduced. Reservoir capacities selected in the upper Ohio River Basin area under these conditions are as follows:

Allegheny Basin	210,000	Acre-feet
Monongahela Basin	370,000	" "
Total	580,000	" "

Organic pollution in the upper main Ohio River can be controlled satisfactorily by a partial treatment of sewage and industrial wastes plus flow control adequate to eliminate those low-flow periods when a higher degree of treatment would normally be required. A second method of control would be to [illegible] natural flows to remain unchanged and install facilities for providing the required higher degree of treatment.

In estimating the value of flow regulation for organic pollution abatement, this value was considered as equal to the difference in cost between partial treatment and the required higher degree of treatment.

The required flow has been estimated to be 8,000 c.f.s. during the warm summer months (25°C. or 77°F. average monthly air temperature) and progressively lesser flows as temperatures decrease. With this flow regulation, primary treatment plus equivalent treatment of industrial wastes would be adequate to maintain satisfactory stream conditions for reasonable use other than domestic water supply immediately below Pittsburgh.

The question arises as to the justification of attempting to maintain such conditions during times of abnormally low flow such as occurred during 1930. Conditions of 1930 have occurred but once in a period of record of over 30 years and have not been approached in any other year. If 1930 is included, storage required for flow regulation is 830,000 acre-feet while during all other years storage of 430,000 acre-feet would be adequate. It is concluded that the cost of providing the higher storage capacity is greater than warranted by control of pollution during a drought occurring but once in 30 years. This does not mean that conditions would not be improved during an extreme drought. A valuable partial organic pollution control would be available during a year such as 1930.

Storage required for organic pollution abatement is 430,000 acre-feet (except in 1930) while total storage selected for acid control is 580,000 acre-feet. This last storage figure of 580,000 acre-feet has been used in estimating benefits.

Benefits and Costs

Benefits of the combined program due to acid control are due to a reduction in the damages detailed on Table 9. Benefits to organic pollution control are due to a reduction in the cost of needed sewage and industrial waste treatment.

Reduction in maximum monthly acidities equitably assigned to the two items; mine sealing and flow regulation, of this program are as follows:

	Acidity (1) - P.P.M.	
	Allegheny at Aspinwall	Monongahela abv.McKeesport
Present monthly maximum	23	33
Reduction by sealing (2)	22	19
Reduction by reservoirs (2)	14	10
Resulting monthly maximum	(3)	4

The estimated monetary benefits to acid and hardness reduction in the Allegheny, Monongahela and upper Ohio River Basin due to the suggested mine sealing and flow regulation programs total $1,133,000 per year. This estimate is believed conservative as it is based on 1940 damages instead of greater possible future damages and it does not include benefits to unevaluated and intangible items. Deducting the cost of sealing of $870,000 per year from these benefits leaves $263,000 per year that can be spent on reservoir construction for acid and hardness reduction.

In correcting sewage and organic industrial waste pollution without flow regulation, a higher degree of treatment (estimated as effective chemical treatment) would be required to maintain equivalent stream conditions. Estimated additional annual costs of the selected chemical treatment over primary treatment is $300,000 at Pittsburgh. Flow regulation above Pittsburgh would increase the minimum flow at Cincinnati and this increase would result in savings for similar reasons of an additional $300,000.

While the flow regulation is designed primarily for acid pollution control, minor adjustments in the operating schedule make it possible for the flow regulation also to serve as a valuable aid in organic pollution control. The two flow regulation objectives fit well together as acid discharges are at a minimum during dry periods when augmented flow is required for organic pollution control. An examination of flow and acidity records indicates that acid control and organic pollution abatement can both be accomplished with the exception of one month (also excepting 1930) in ten years and this accomplishment has been taken as satisfactory.

---

(1) To Methyl Red on Allegheny and Methyl Orange on Monongahela.

(2) Equitably assigned or average improvement if remedy applied constructed first or second. As a rule, projects applied first show increased benefits at expense of later projects.

(3) 13 p.p.m. minimum alkalinity.

Annual benefits to flow regulation include $263,000 left after deducting mine sealing costs from acid and hardness control benefits, plus $300,000 for organic pollution control at Pittsburgh and $300,000 for organic pollution control benefits at Cincinnati, making a total of $863,000 per year. For a storage of 580,000 acre-feet, the annual benefits or the amount that can be economically spent per acre-foot per year is $1.49.

A summary of the cost and benefit relation is as follows:

	Annual Benefits and Costs
Benefits - Acid Control	$ 1,133,000
Cost - Mine Sealing To date and Future	870,000
Balance - Acid Control for Reservoirs	263,000
Benefits - Organic Pollution Control	
Pittsburgh	300,000
Cincinnati	300,000
Total available for reservoirs	$863,000
Per Acre-Foot	$1.49

Reservoir benefits are, in large measure, due to equalizing and surge reducing effects following mine sealing in order to develop full benefits from the sealing program. The balance for reservoirs indicated is, therefore, available to the extent shown only if and when the mine sealing program is assured. Mine sealing, on the other hand, can be justified beyond reasonable doubt as a single independent remedial measure.

Studies conducted by the Corps of Engineers disclose that storage capacity can be provided in the quantities required for low-flow control in the Allegheny-Monongahela-Upper Ohio River Basin. It is further indicated that the best development of the water resources of the basin would provide low-flow control as a function of multiple-purpose reservoir operation. Under such circumstances, the average annual benefits which could be reasonably assigned to such an improvement would be in excess of the average annual cost.

INTRODUCTION TO DRAINAGE BASIN SUMMARIES

The basic information of the Ohio River Pollution Survey has been presented in summaries covering the main Ohio River, minor tributary basins and the nineteen major tributary basins. An effort has been made to have each summary complete in itself. Certain explanations, applicable to each, have been made in this section to avoid repetition.

In so far as possible, information for each basin is presented in as near identical form as possible, according to the following general outline:

Syllabus and Conclusions
Description
Presentation of Field Data
Presentation of Laboratory Data
Hydrometric Data
Discussion

Accompanying the text are a number of tables, maps and charts. With the exception of the division on the main Ohio River, similarly numbered tables and figures cover similar material in each basin summary.

In the tabulations of costs (Table 1) the annual charges are based on interest rates of 3½% for municipal and 5% for industrial construction and periods for amortization of 40 years for interceptors, 20 years for municipal treatment plants and 10 years or less for industrial corrective measures. Studies of interest rates and life of treatment facilities have indicated that these figures represent about the average experience of municipalities and industries. Cost estimates of individual projects are not shown except in a few cases where they are based on engineering surveys. Since most of the estimates are not based on detailed studies of each situation they may be considerably in error in individual instances. Grouped for an entire basin, the probability of error is greatly reduced and it is believed that the figures shown are an accurate indication of the cost of the suggested pollution abatement program. Costs of providing lateral sewers or for the extension of sewers to areas now lacking them are not included in the estimates.

The urgency of the individual projects for which cost estimates have been made is far from uniform. Some projects are needed to correct critical pollution conditions while in other cases the need and justification for the expenditure is less outstanding. The basin summaries place stress on the more critical and larger sources of pollution where effects are not confined to local areas. However, cost estimates presented apply not only to the urgent situations but to a oomplete program of pollution control such as might take place during the course of the next 10 to 20 years. In the special case of a stream highly acid from the effects of mine drainage, expenditure of public funds for acid reducing measures should precede or at least parallel expenditures for sewage and organic pollution abatement.

Cost estimates are based on average experience from 1928 to 1940. Costs for 1942 would be considerably higher and future costs will probably be subject to further change depending upon fluctuation in construction costs for this type of work.

Throughout the report quantities of organic industrial wastes have been expressed as "sewered population equivalent (B.O.D.)."* Extensive measurements have shown that the average oxygen demand of domestic sewage is 0.168 pound (5-day, 20°C.) per capita per day and this factor has been used to convert industrial waste loads to a readily understandable basis. In the tabulations of sources of pollution (Table 3), the column "Sewered Population Equivalent (B.O.D.), Untreated" represents the total of the population connected to sewers plus the population equivalent of industrial wastes discharged at each locality. The difference between this column and the adjacent column "Sewered Population Equivalent (B.O.D.), Discharged" represents the reduction in the pollution load due to treatment in a municipal treatment plant.

Where accurate laboratory results of treatment plant operation were available, these were used to determine the pollution load both before and after treatment. In the absence of such records reductions of 35% by primary treatment and 85% by secondary treatment were assumed.

No differentiation has been made in the tables, maps or charts between industrial wastes which are discharged only seasonally and those which are discharged throughout the year. The pollution loading shown represents conditions during normal operations at the height of the season. In the case of the canning industry, this may occur only during a few weeks in the year but these few weeks are often during the late summer when the effects of organic pollution on the oxygen balance of the stream are most serious. On the other hand, the season for distillery operations in most cases is during the winter months when the effects of oxygen-depleting pollution are less serious.

---

* Biochemical Oxygen Demand (5-day, 20°C.)

Nowhere in the report has a quantitative statement been made as to the reduction in the industrial waste pollution load due to treatment, recovery, or other measures at the industrial plant. Such a statement would necessitate a definition of the strength of untreated industrial wastes from each type of industry. This is impracticable since the strength of the wastes depends to a large degree on plant practices which vary widely. For instance, in some meat packing plants all blood, paunch manure and offal are recovered and in others these materials are discharged to the plant sewers. Wastes discharged from vegetable canneries have been found to vary by as much as 400% due to differences in "housekeeping" methods. Wastes from paper mills vary depending on the use of save-alls, recirculating systems and other pollution reduction measures. At some plants reduction in pollution is inadvertent and is brought about by the recovery of valuable by-products or prevention of waste of raw materials. At others expense is incurred which produces nothing but a reduction in pollution discharges. Tabulations of industrial wastes (Table 4) shows the number of plants that have taken steps of either kind which result in some reduction in the pollution load from the plant.

MAIN OHIO RIVER

Final Report to the Ohio River Committee

Ohio River Pollution Survey

U. S. Public Health Service
Cincinnati, Ohio
1942

77.A

MAIN OHIO RIVER

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Fig. Oh-1

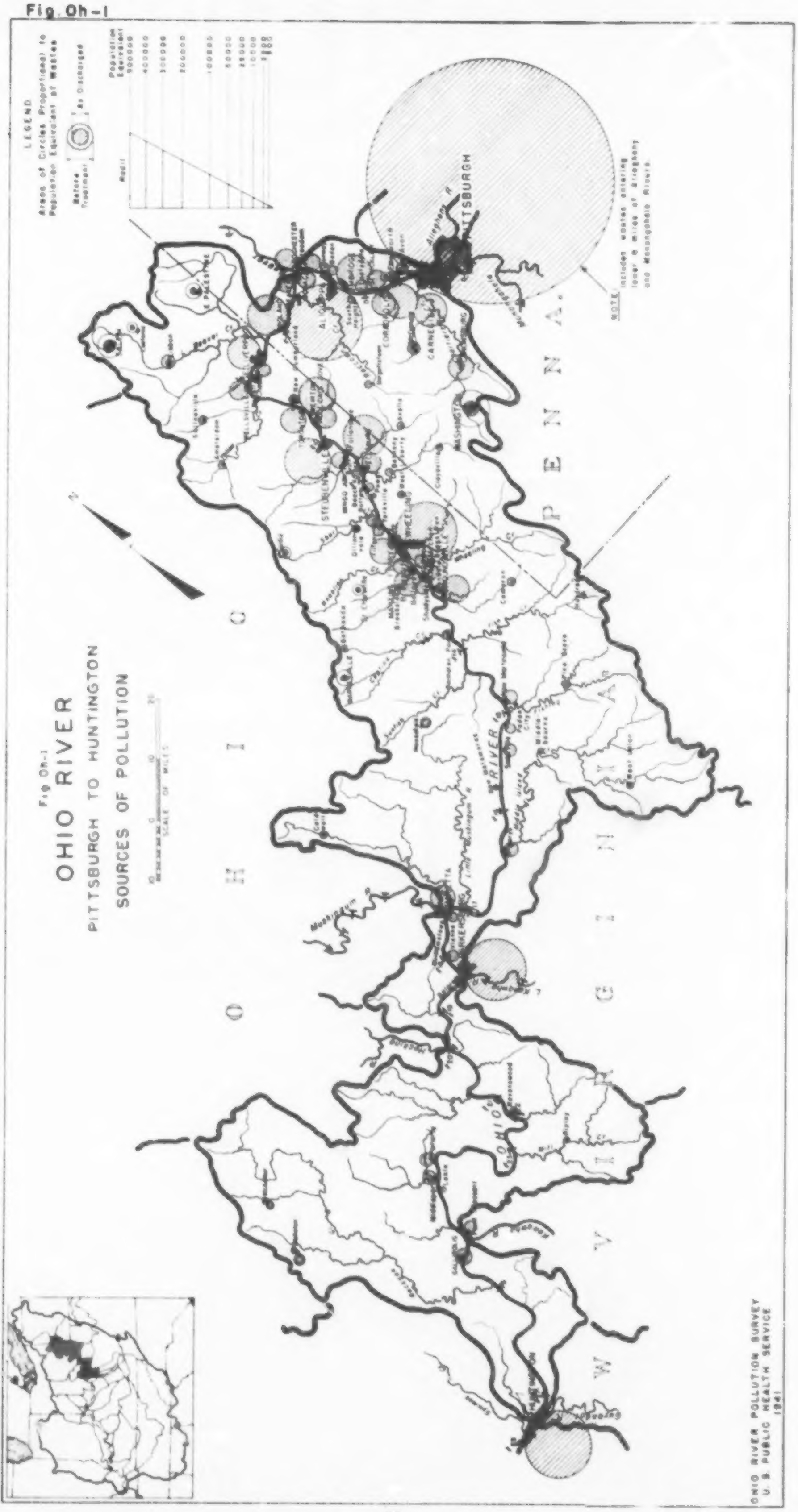

Fig. Oh-1
OHIO RIVER
PITTSBURGH TO HUNTINGTON
SOURCES OF POLLUTION

LEGEND
Areas of Circles Proportional to Population Equivalent of Wastes
Before Treatment
As Discharged
Radii
Population Equivalent
500000
400000
300000
200000
100000
50000
25000
10000
5000
SCALE OF MILES
0
10
20
N
PITTSBURGH
Allegheny R.
NOTE Includes wastes entering lower 8 miles of Allegheny and Monongahela Rivers.
CARNEGIE
WASHINGTON
STEUBENVILLE
WHEELING
AMBRIDGE
CORAOPOLIS
ALIQUIPPA
E. PALESTINE
WELLSVILLE
Muskingum R.
Kanawha R.
OHIO RIVER
OHIO
W. VIRGINIA
PENNA.
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

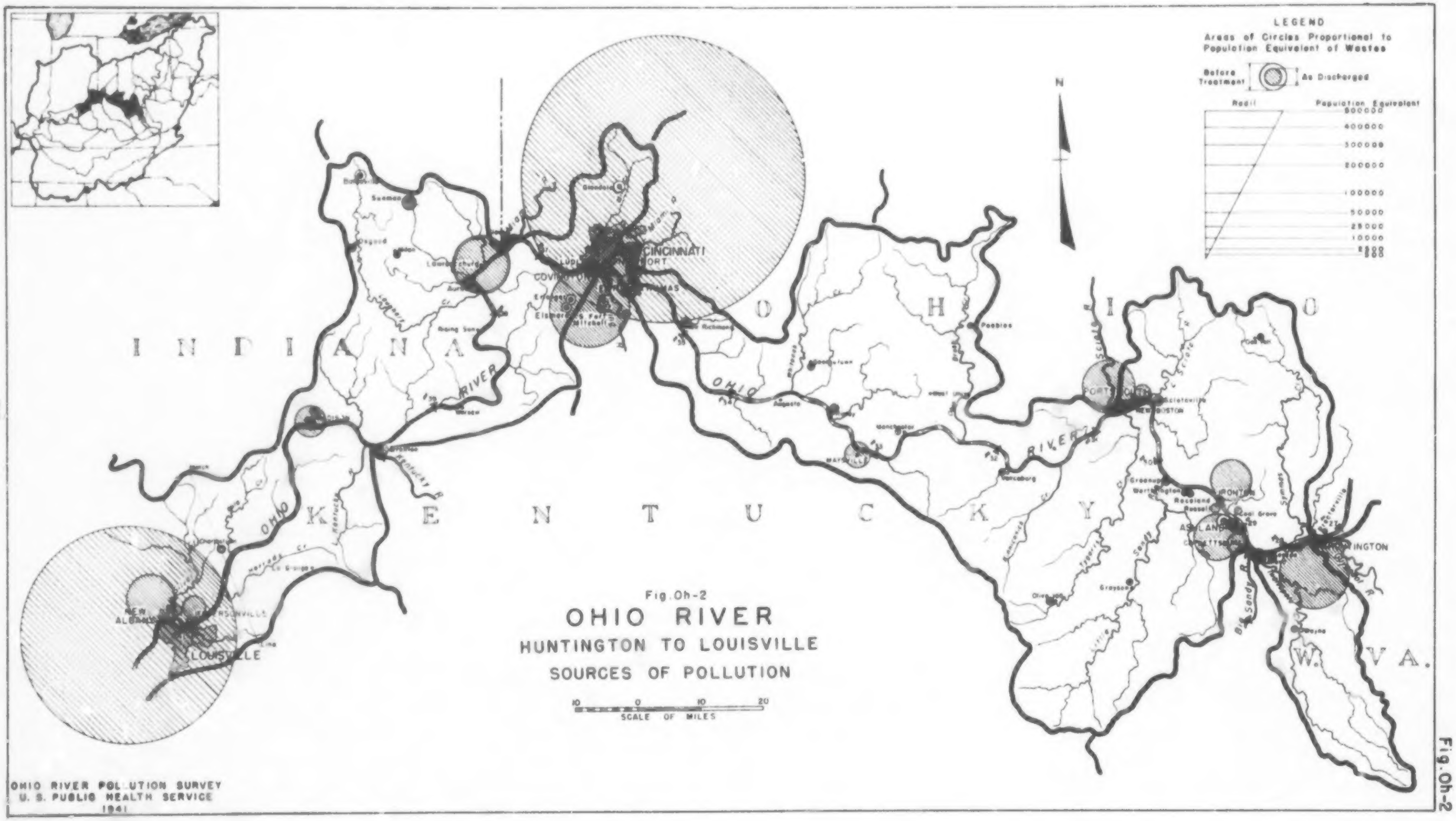
LEGEND
Areas of Circles Proportional to Population Equivalent of Wastes
Before Treatment
As Discharged
Radii
Population Equivalent
500000
400000
300000
200000
100000
50000
25000
10000
2500
500
N
INDIANA
OHIO
KENTUCKY
W. VA.
OHIO RIVER
CINCINNATI
NEWPORT
COVINGTON
LOUISVILLE
NEW ALBANY
JEFFERSONVILLE
MAYSVILLE
PORTSMOUTH
NEW BOSTON
Sciotoville
Vanceburg
Greenup
Worthington
Raceland
Russell
IRONTON
Coal Grove
ASHLAND
Catlettsburg
HUNTINGTON
Big Sandy R.
Grayson
Olive Hill
Peebles
Ceredo
Kenova
Wayne
10 0 10 20
SCALE OF MILES
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig.Oh-2

OHIO RIVER

HUNTINGTON TO LOUISVILLE

SOURCES OF POLLUTION

Fig. Oh-3

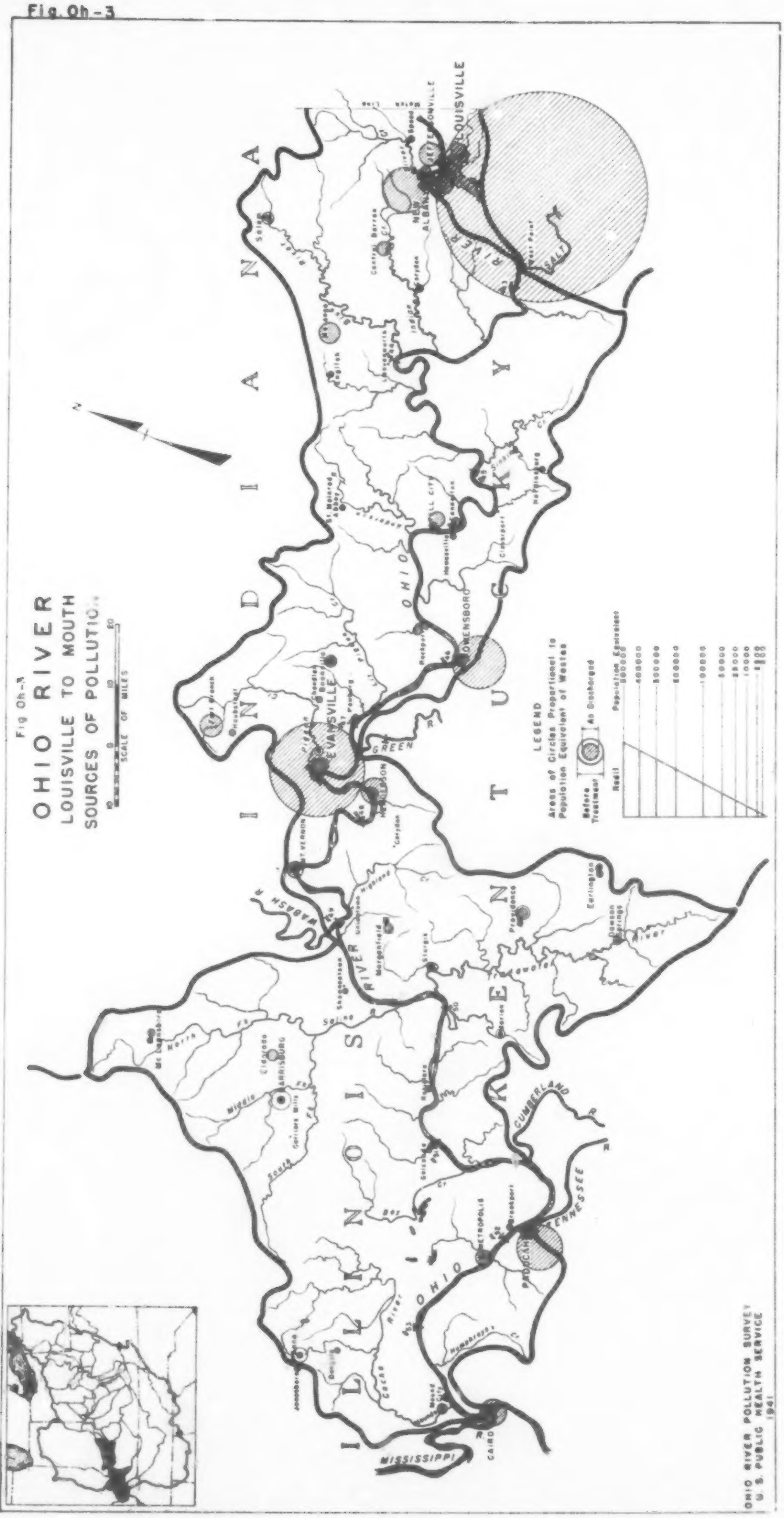
Fig Oh-3
OHIO RIVER
LOUISVILLE TO MOUTH
SOURCES OF POLLUTION
SCALE OF MILES
LEGEND
Areas of Circles Proportional to Population Equivalent of Wastes
Before Treatment
As Discharged
Radii
Population Equivalent
INDIANA
KENTUCKY
ILLINOIS
LOUISVILLE
JEFFERSONVILLE
NEW ALBANY
OWENSBORO
EVANSVILLE
HENDERSON
MT VERNON
PADUCAH
METROPOLIS
CAIRO
HARRISBURG
OHIO
GREEN R
WABASH R
CUMBERLAND R
TENNESSEE
MISSISSIPPI
SALT
OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

MAIN OHIO RIVER

Syllabus and Conclusions

Syllabus

The Ohio River is one of the most intensively used large streams in the United States, supplying water for municipal and industrial use, furnishing a method of sewage and industrial waste disposal, providing transportation facilities and providing many sources of recreation. Pittsburgh, Cincinnati and Louisville, the largest urban centers on the river, contribute the largest amounts of pollution and there are more than 100 smaller places discharging untreated sewage and wastes. Municipal sewage, acid mine drainage and industrial wastes, such as phenols, which impart objectionable tastes and odors to drinking water are the principal polluting substances.

The interstate character of the Ohio River is in part responsible for the lack of progress made to date in controlling the pollution of the stream. The Ohio River Valley Water Sanitation Compact, which has been approved by the Congress and ratified by four of the State Legislatures, pledges the states to joint action for pollution abatement and provides for an interstate administrative agency. This compact should be ratified by the remaining state necessary to make it operative.

This report presents a summary of the information collected and outlines a program of sewage and industrial waste treatment for the main Ohio River. Such a program, coupled with a basin-wide program of mine sealing, low-flow augmentation and similar programs of waste treatment on certain tributary streams would provide an economical and effective method of reducing the pollution of the Ohio River.

Conclusions

(1) Thirty public water supplies serving 1,663,000 people are taken from the Ohio River proper.

(2) Sewage from about 2,700,000 people and industrial wastes equivalent in oxygen demand to sewage from an additional 2,850,000 people enter the Ohio River and the lower stretches of tributary streams. Only about one per cent of the sewage is treated prior to discharge.

(3) Laboratory surveys made during 1939-41 showed notable oxygen sags below Cincinnati and Pittsburgh and heavy bacterial pollution below these points and many other cities and at a number of waterworks intakes. The main stream was found to be acid as far downstream as Marietta, Ohio, during a part of the sampling period. It is known to have been acid further downstream on other occasions. In general, the tributaries are in as good or better sanitary condition at their mouths than the main stream and the effect of tributary inflow is not particularly noticeable.

(4) The major pollution control measures needed on the main river are: (a) reduction of bacterial pollution, particularly at water supply intakes; (b) reduction and prevention of the further spread downstream of acidity; (c) prevention of taste and odor troubles in public water supplies; and (d) correction of objectionable nuisance conditions due to oxygen depletion, discoloration of the stream, floating sewage and other solids and scum.

(5) Efficient primary treatment of sewage plus continuous chlorination should effectively reduce bacterial pollution. Primary treatment of sewage and organic industrial wastes should correct nuisance conditions in the stream, except below Cincinnati and Pittsburgh, when very low flows and high water temperatures prevail. Supplementary measures of low-flow augmentation or chemical treatment would correct these conditions.

(6) Prevention of taste and odor troubles will require special industrial waste treatment at by-product coke plants, at some chemical plants and at other establishments with similar types of wastes.

(7) Reduction in acidity can be most effectively and economically achieved by a basin-wide program of mine sealing combined with a program of low-flow augmentation*. Neutralization of waste industrial acids would aid in reducing acidity.

(8) The following estimates of cost of existing works and of a suggested program of sewage and industrial waste treatment is summarized from Table Oh-1. The bulk of the cost for new work is at Pittsburgh, Cincinnati and Louisville.

Treatment	Capital Cost	Annual Charges
Existing	$1,080,000	$95,000
Suggested additional	71,030,000	6,710,000

The estimated additional cost over existing charges of a program involving secondary treatment at all sources of pollution on the Ohio River is:

Primary, all places	$71,030,000	$6,710,000
Secondary, all places	86,620,000	8,700,000

---

* See section of report on Acid Mine Drainage.

Table Oh-1 Main Ohio River - Estimated Cost of Existing and Suggested Minimum Corrective Measures for Sewage and Industrial Wastes, with Comparative Costs for Primary and Secondary Treatment.

	Number of Plants		Population Connected to Sewers	Capital Investment (Dollars)	Annual Charges (Dollars)		
	Prim.	Sec.			Amort. & Interest	Operation & Main.	Total
Existing Sewage Treatment	4	16	22,500	1,080,000	65,000	30,000	95,000
Suggested Minimum Correction							
Sewage Treatment Plants	111	0	2,018,500	27,560,000	1,940,000	1,765,000	3,705,000
Required Interceptors	-		-	40,350,000	1,890,000	-	1,890,000
Independent Industrial Waste Correction				3,120,000	410,000	705,000	1,115,000
Total				71,030,000	4,240,000	2,470,000	6,710,000
Comparative Cost							
Primary Treatment All Waste				71,030,000	4,240,000	2,470,000	6,710,000
Secondary Treatment All Waste				86,620,000	5,335,000	3,365,000	8,700,000
As Suggested				71,030,000	4,240,000	2,470,000	6,710,000

NOTE: Costs shown above include the cost of interceptors and treatment works for city of Pittsburgh and its suburbs along the lower Allegheny and Monongahela Rivers and Chartiers Creek whose wastes would probably be treated at a plant along the Ohio River.

Description

The Ohio River is formed by the junction of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, and flows in a generally southwesterly direction for 981 miles to its confluence with the Mississippi River. It forms the boundary between five states; Ohio, Indiana and Illinois on the north and West Virginia and Kentucky on the south. The 203,900 square miles drained by the Ohio River and its tributaries comprise roughly one-fifteenth of the area of the United States and include parts of fourteen states. Most of this area is drained by the 19 major tributaries which are discussed separately. About 23,780 square miles of the watershed drain directly into the Ohio River or through minor tributaries. This section of the report is concerned only with the cities and towns on the Ohio River proper or in metropolitan areas which touch the river.

The three largest cities on the Ohio River are Pittsburgh, Cincinnati and Louisville. There are 86 incorporated municipalities of more than 2,500 population on the Ohio River and 131 additional smaller incorporated towns. The population of some of the larger cities and of the entire area is shown below.

	Population			
Principal Cities	1910	1920	1930	1940
Pittsburgh, Pa.	533,905	588,343	669,817	671,659
Cincinnati Ohic	363,591	401,247	451,160	455,610
Louisville, Ky.	223,928	234,891	307,745	319,077
Evansville, Ind.	69,647	85,264	102,249	97,062
Huntington, W.Va.	31,161	50,177	75,572	78,836
Covington, Ky.	53,270	57,121	65,252	62,018
Wheeling, W.Va.	41,641	56,208	61,659	61,099
Entire Area				
Urban	1,839,366	2,133,585	2,540,749	2,570,592
Rural*	120,993	118,004	115,251	127,217
Total	1,960,359	2,251,587	2,656,000	2,697,809

Most of the Ohio River cities are relatively old and their rate of growth during this century has been less rapid than that of other cities in the basin.

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* Includes only incorporated communities of less than 2,500 population on the Ohio River or in metropolitan areas along the stream.

Steel production is the outstanding single industry in the Ohio Valley and is predominant in the section above Wheeling. Most of the Ohio River cities below the steel area are more important from the standpoint of commerce and transportation rather than as industrial centers.

Water Uses - Forty-six locks and dams provide slack-water navigation for boats at nine foot draft for the entire length of the river. A number of additional locks and dams have been replaced by fewer structures of higher lift. In 1940 almost 30,000,000 tons of freight, the bulk of which was coal, were moved by river.

The only hydroelectric development on the Ohio River is at Dam #41 at Louisville. Relatively small amounts of power might be generated at some of the navigation dams.

The floods of 1936 and 1937 focused national attention on the need for flood protection along the Ohio River. Studies by the U. S. Engineer Department have indicated the value of reservoirs on tributaries in reducing flood damages along the main stream. Tributary reservoirs are discussed in the basin summaries of this report. A number of possible sites for high dams on the Ohio River have been studied but none have been constructed nor authorized by the Congress.

In spite of many drawbacks the Ohio River is used extensively for recreation. There are numerous boat and yacht clubs and a number of bathing beaches are well patronized. There is considerable sport fishing in some sections of the main stream but much more on minor tributaries. Commercial fishing is practically limited to the lower half of the main stream and is not of great importance.

Presentation of Field Data

Figures Oh-1, Oh-2 and Oh-3 show the location and magnitude of the more important sources of pollution along the upper, middle and lower thirds of the main Ohio River respectively. Figures Oh-4, Oh-5 and Oh-6 show similar data and, in addition, the location of water supply intakes and selected laboratory data on coliform organisms, dissolved oxygen and B.O.D.

Public Water Supplies - Thirty public water supplies serving 1,663,000 people are taken from the Ohio River. The three largest supplies (Cincinnati, Louisville and Evansville) serve a total of more than one million people. Table Oh-2 shows data on the Ohio River supplies and on three other surface supplies developed by Ohio River communities from unpolluted sources. The heavy pollution at many of the water intakes necessitates very careful and complete treatment of the water. The supplies subject to the heaviest pollution are those in the upper 100 miles of the river, and those at Ashland, Ironton, Portsmouth, Aurora, New Albany and Henderson. The Cincinnati, Covington and Newport supplies, which are taken from the river within one mile of each other, and the Louisville supply are somewhat less seriously polluted. Several million dollars have been spent in recent years to improve water treatment plants because of heavy bacterial loadings and taste and odor difficulties.

Sewerage - Table Oh-3 shows the sewered population and the total waste load at communities on the main Ohio River. Table Oh-3 and Figures Oh-1 to Oh-6 show the size and distribution of these sources of pollution. Sewage from more than two million people is discharged at these places, only about one percent of which is treated. In addition, sewage from about 640,000 people enters the lower Allegheny and Monongahela in the Pittsburgh area just above the source of the Ohio River, and sewage from about 78,000 people enters the Little Miami River near its mouth, at Cincinnati. The concentrations of population and pollution in the upper 100 miles from Pittsburgh to below Wheeling; in the area from Huntington to Portsmouth; around Cincinnati; Louisville, and Evansville, are notable.

Industrial Wastes - The oxygen demand of industrial wastes entering the Ohio River is equivalent to that of sewage of about 2,400,000 people. Industrial wastes with an additional population equivalent of about 415,000 enter the lower Allegheny and

Monongahela at Pittsburgh, and the Little Miami at Cincinnati receives industrial wastes with a population equivalent of about 50,000. Table Oh-4 summarizes the industrial waste load by type of industry and method of disposal with the exception of the industries at Cincinnati which were not surveyed individually. Distilleries, by-product coke plants, meat processing plants and breweries are the largest sources of organic industrial wastes outside of Cincinnati. At Cincinnati, soap, fertilizer, glue, paper, and meat plants, tanneries, and breweries are the principal sources of industrial wastes.

More than eighty percent of the organic industrial waste load is discharged from the Cincinnati area and downstream, the largest concentrations being at Cincinnati and Louisville (see Table Oh-3). The largest sources of organic industrial wastes along the Ohio above Cincinnati are the by-product coke plants associated with blast furnaces in the steel producing area. All of these plants are located above the Scioto River.

The principal industry along the upper river is steel production and, although large amounts of water are used in the steel mills, deleterious wastes are practically limited to spent acids used in pickling. A total of about 120,000 pounds of acid per day are discharged from the 62 steel plants along the river and almost all of this enters the upper 100 miles of the stream which is acid for a considerable part of the time, principally because of mine drainage.

Table Oh-2 Main Ohio River - Surface Water Supplies

Supply	State	Source	Mile (1)	Treatment (2)	Population Served	Cons. M.G.D.
Supplies Below Community Sewer Outfalls						
Cairo	Ill.	Ohio River	4.5	FD	12,000	2.50
Paducah	Ky.	" "	46.9	FD	33,800	2.75
Golconda	Ill.	" "	78.5	FD	600	0.03
Rosiclare	"	" "	90.0	FD	1,800	0.08
Morganfield (3)	Ky.	" "	137.0	FD	3,000	0.17
Uniontown	"	" "	140.7	FD	300	0.01
Mt.Vernon	Ind.	" "	151.9	FD	5,600	0.75
Henderson	Ky.	" "	178.0	FD	14,000	3.50
Evansville	Ind.	" "	189.4	FD	105,000	11.10
New Albany	"	" "	372.6	FD	25,000	2.00
Louisville	Ky.	" "	380.5	FD	350,000	43.70
Aurora	Ind.	" "	484.3	FD	1,200	0.27
Newport	Ky.	" "	517.3	FD	56,500	4.00
Covington	"	" "	518.1	FD	96,800	7.50
Cincinnati	Ohio	" "	518.2	LD	560,000	61.30
Maysville	Ky.	" "	572.6	FD	8,000	0.33
Portsmouth	Ohio	" "	630.1	FD	55,000	3.60
Ironton	"	" "	653.8	FD	18,000	1.00
Ashland	Ky.	" "	661.1	FD	45,000	1.81
Huntington	W.Va.	" "	676.8	FD	89,000	6.00
Pomeroy	Ohio	" "	732.7	FD	6,000	0.40
Sistersville	W.Va.	" "	843.7	FD	2,800	0.65
Bellaire	Ohio	" "	887.0	FD	13,800	3.10
Wheeling	W.Va.	" "	894.2	FD	70,000	5.00
Steubenville	Ohio	" "	915.7	FD	37,600	3.46
Weirton	W.Va.	" "	918.5	FD	14,000	1.00
Toronto	Ohio	" "	921.9	LD	7,400	0.30
East Liverpool	"	" "	940.8	FD	23,000	3.50
Midland	Pa.	" "	945.1	FD	6,300	0.40
Dixmont Hosp.	"	" "	973.4	FD	1,500	0.67
Other Surface Supplies						
Brooksville	Ky.	Impounded		FD	500	0.02
New Cumberland	W.Va.	Spr.-Well-Impounded		D	2,000	0.06
Wellsville	Ohio	Impounded		FD	7,700	1.15
Total - Below Sewer Outfalls					1,663,000	170.88
Other					10,200	1.23
Total - Surface Water Supplies					1,673,200	172.11

(1) Location of intake in miles above mouth of Ohio River.
(2) F - Coagulated, settled, filtered. L - Lime-soda softened.
D - Chlorinated.
(3) Community on minor tributary of Ohio River but water supply from main stream.

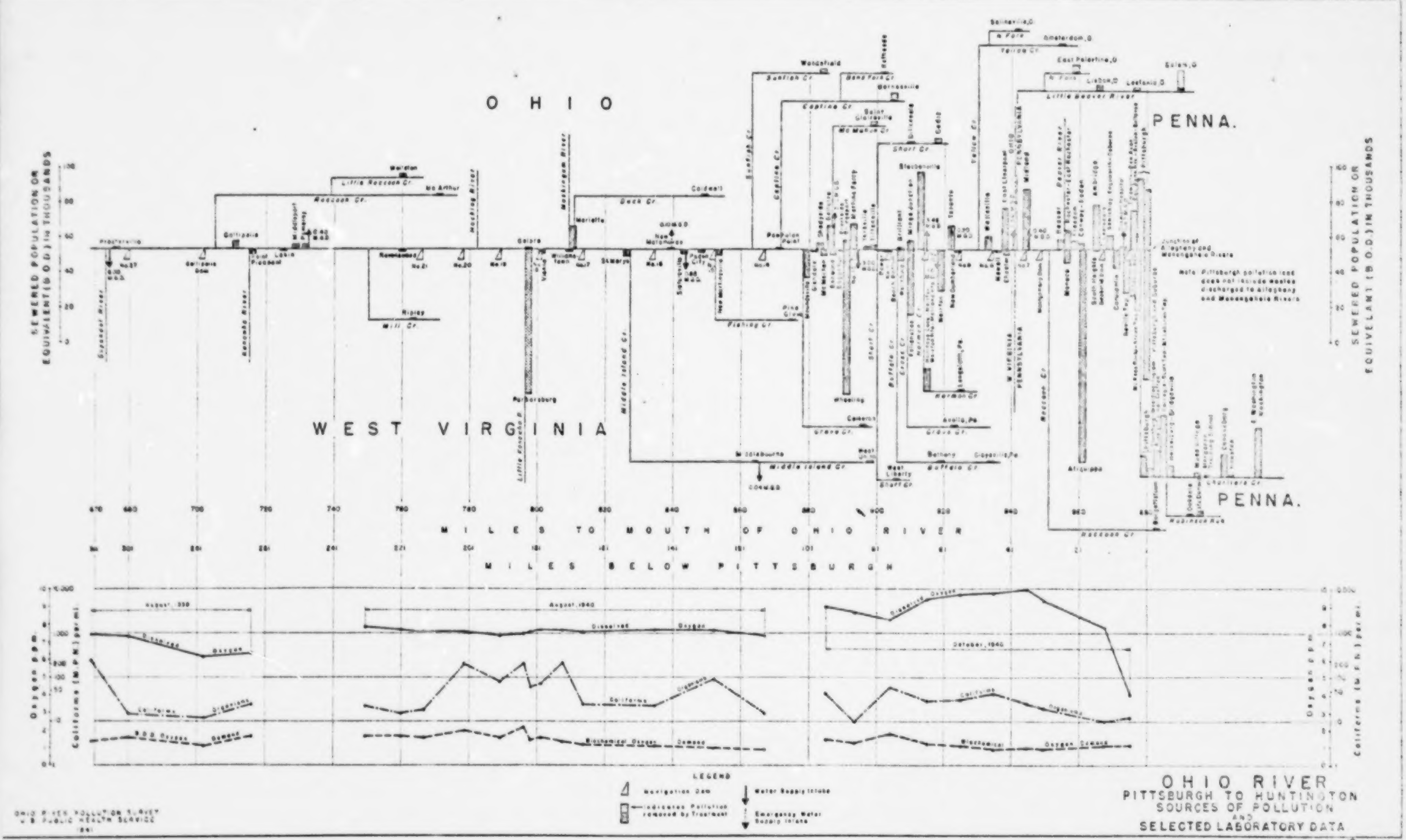
Table Oh-3 Main Ohio River - Sources of Pollution Including Industrial Wastes Expressed as Sewered Population Equivalent (B.O.D.) (1)

Municipality	State	River Miles Above Mouth	River Miles Below P'gh.	Population Connected to Sewers	Treatment	Sewered Population Equivalent (B.O.D.) Untreated	Sewered Population Equivalent (B.O.D.) Discharged
Cairo	Ill.	2	979	12,000	None	12,000	12,000
Metropolis	"	37	944	4,200	"	4,200	4,200
Paducah	Ky.	46	935	29,000	"	39,600	39,600
Mt. Vernon	Ind.	152	829	4,200	"	6,000	6,000
Henderson	Ky.	177	804	11,000	"	14,000	14,000
Evansville	Ind.	189	792	103,500	Secondary(3)	192,300	191,200
Owensboro	Ky.	222	759	25,600	None	64,400	64,400
Tell City	Ind.	254	727	3,500	"	4,700	4,700
New Albany-Silver Hills	"	372	609	18,300	"	40,600	40,600
Louisville & Suburbs	Ky.	377	604	304,300	"	906,900	906,900
Jeffersonville-Clarksville	Ind.	378	603	12,500	"	14,100	14,100
Madison	"	423	558	7,[illegible]00	"	18,900	18,900
Lawrenceburg	"	488	493	2,500	Secondary	74,000	71,900
Cincinnati & Suburbs (2)	Ohio	507	474	512,400	None	1,569,400	1,569,400
Covington & Suburbs	Ky.	510	471	77,800	Secondary(3)	145,900	141,600
Newport & Suburbs	"	511	470	60,800	" "	69,400	67,800
Maysville	"	572	409	6,000	None	13,000	13,000
Portsmouth-New Boston	Ohio	625	356	45,500	Primary (3)	60,000	59,100
Ironton	"	653	328	12,500	None	32,500	32,500
Ashland	Ky.	658	323	21,000	Secondary(3)	46,100	43,100
Catlettsburg	"	663	318	3,400	None	8,400	8,400
Ceredo-Kenova	W.Va.	666	315	5,100	"	5,100	5,100
Huntington	"	672	309	75,000	"	95,800	95,800
Gallipolis	Ohio	711	270	5,000	"	5,000	5,000
Pomeroy-Middleport	"	729	252	6,000	"	6,000	6,000
Parkersburg	W.Va.	796	185	36,000	"	82,000	82,000
Marietta	Ohio	809	172	13,000	"	13,000	13,000
Moundsville	W.Va.	879	102	16,000	"	16,000	16,000
Bellaire	Ohio	886	95	13,500	"	13,500	13,500
Wheeling & Suburbs	W.Va.	890	91	67,300	"	90,100	90,100
Bridgeport-Brookside	Ohio	891	90	5,600	"	5,600	5,600
Martins Ferry	"	892	89	14,700	"	14,700	14,700
Wellsburg	W.Va.	906	75	5,500	"	6,400	6,400
Mingo Junction	Ohio	910	71	5,100	"	5,100	5,100
Follansbee	W.Va.	910	71	4,800	"	36,800	36,800
Steubenville	Ohio	913	68	32,000	"	44,000	44,000
Weirton & Suburbs	W.Va.	919	62	16,700	"	36,500	36,500
Toronto	Ohio	921	60	7,000	"	13,700	13,700
Wellsville	"	933	48	7,600	"	7,600	7,600
East Liverpool	"	937	44	21,000	"	23,600	23,600
Midland	Pa.	944	37	6,300	"	34,300	34,300
Beaver	"	954	27	5,600	"	5,600	5,600
Rochester	"	956	25	10,000	"	10,000	10,000
Monaca	"	956	25	8,000	"	8,000	8,000
Freedom	"	957	24	3,200	"	4,900	4,900
Aliquippa	"	961	20	27,000	"	120,000	120,000
Ambridge	"	965	16	25,000	"	25,000	25,000
Sewickley	"	969	12	5,600	"	5,600	5,600
Coraopolis	"	971	10	10,200	"	10,800	10,800
Neville Twp.	"	973	8	1,500	"	24,400	24,400
Emsworth-Ben Avon	"	975	6	5,200	"	5,200	5,200
Bellevue-Avalon	"	976	5	16,800	"	16,800	16,800
Pittsburgh & Suburbs(6)(4)	"	980	1	261,700	"	278,600	278,600
65 Smaller Sources				72,700	(5)	78,100	75,300
Total - Illinois				18,500		18,700	18,400
Indiana				157,400		357,000	353,500
Kentucky				545,700		1,316,300	1,307,000
Ohio				719,200		1,833,700	1,832,200
Pennsylvania				397,300		560,400	559,200
West Virginia				254,100		398,100	398,100
Total Entire Stream				2,092,200		4,484,200	4,468,400

(1) Includes communities on Ohio River and other adjacent communities which probably will discharge waste directly to the river when sewage treatment facilities are provided.
(2) Exclusive of wastes now entering Little Miami River.
(3) Small portion of sewage treated.
(4) Exclusive of wastes now entering Allegheny and Monongahela Rivers.
(5) Secondary treatment at 3 places, primary at 3, none at others.
(6) Pollution loads from Pittsburgh and Suburbs are distributed to Allegheny and Monongahela Basins and Main Ohio River as follows:

Pittsburgh and Suburbs	Allegheny R.	Pa.	0-8	-	320,500	None	597,200	597,200
	Monongahela R.	"	0-10	-	319,500	"	458,500	458,500
	Ohio River	"	-	0-4	261,700	"	278,600	278,600
Total	-	-	-	-	901,700	-	1,334,300	1,334,300

Fig. 09-a

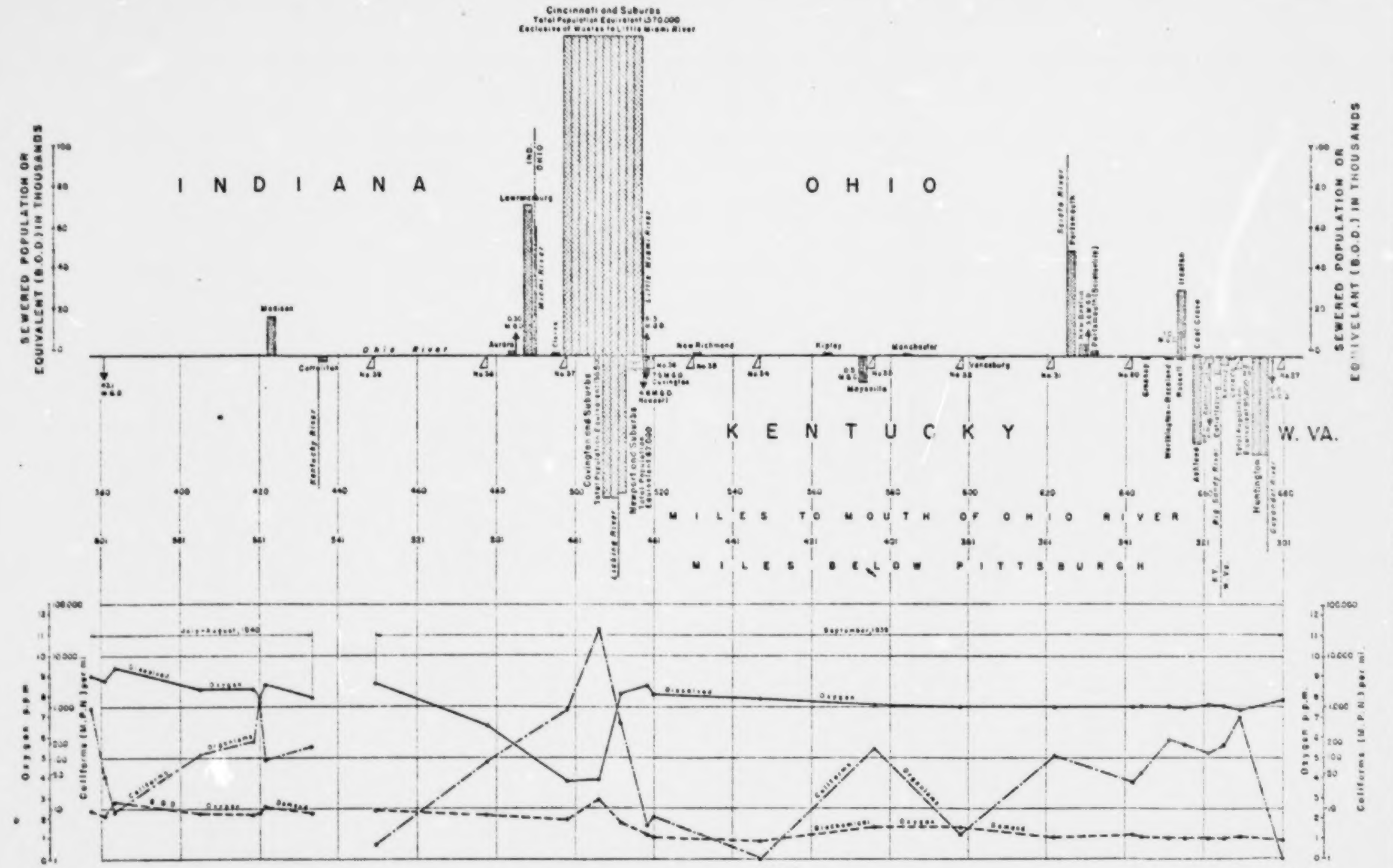


OHIO RIVER
PITTSBURGH TO HUNTINGTON
SOURCES OF POLLUTION
AND
SELECTED LABORATORY DATA

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

92-A

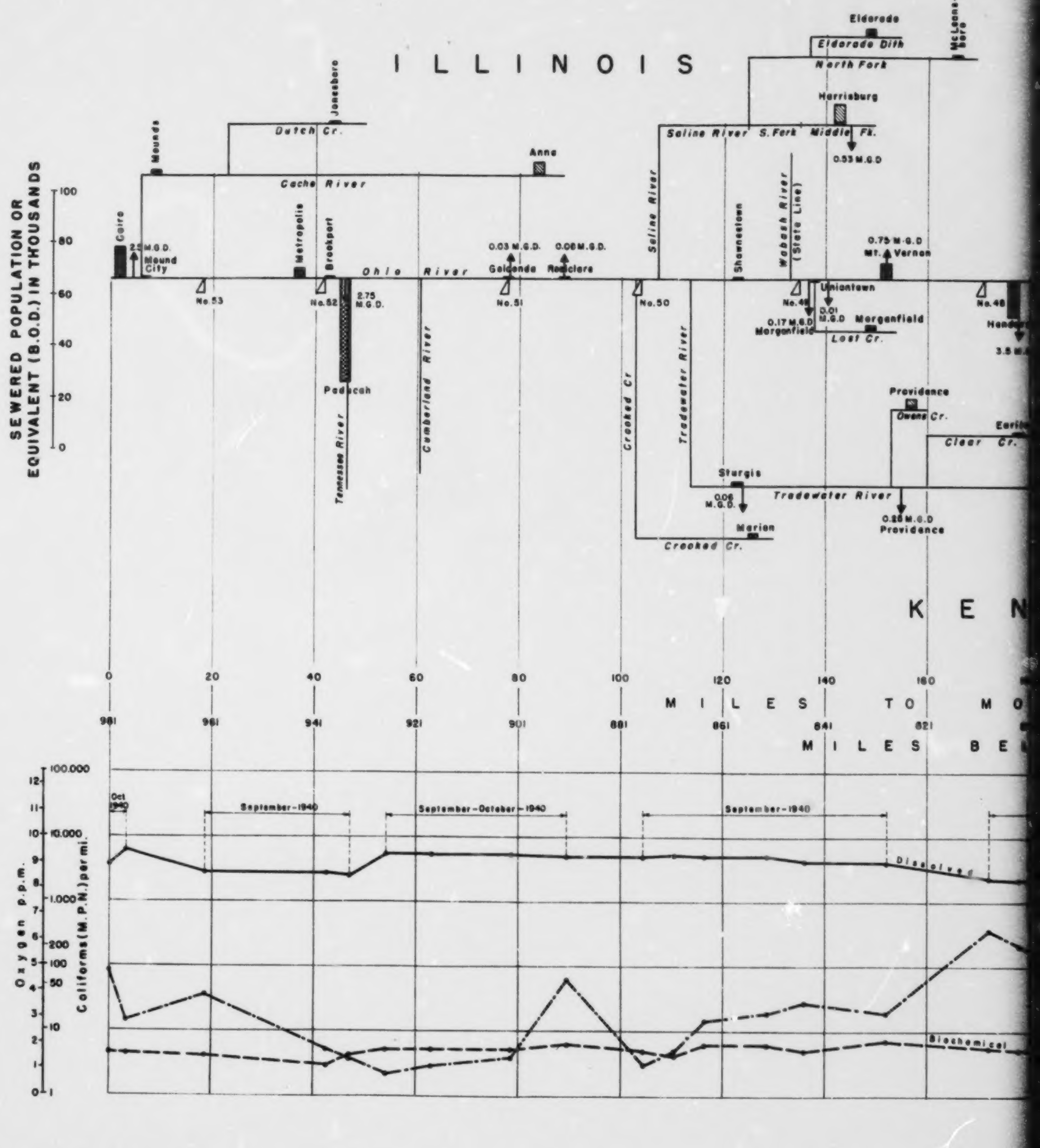
Fig Oh-5



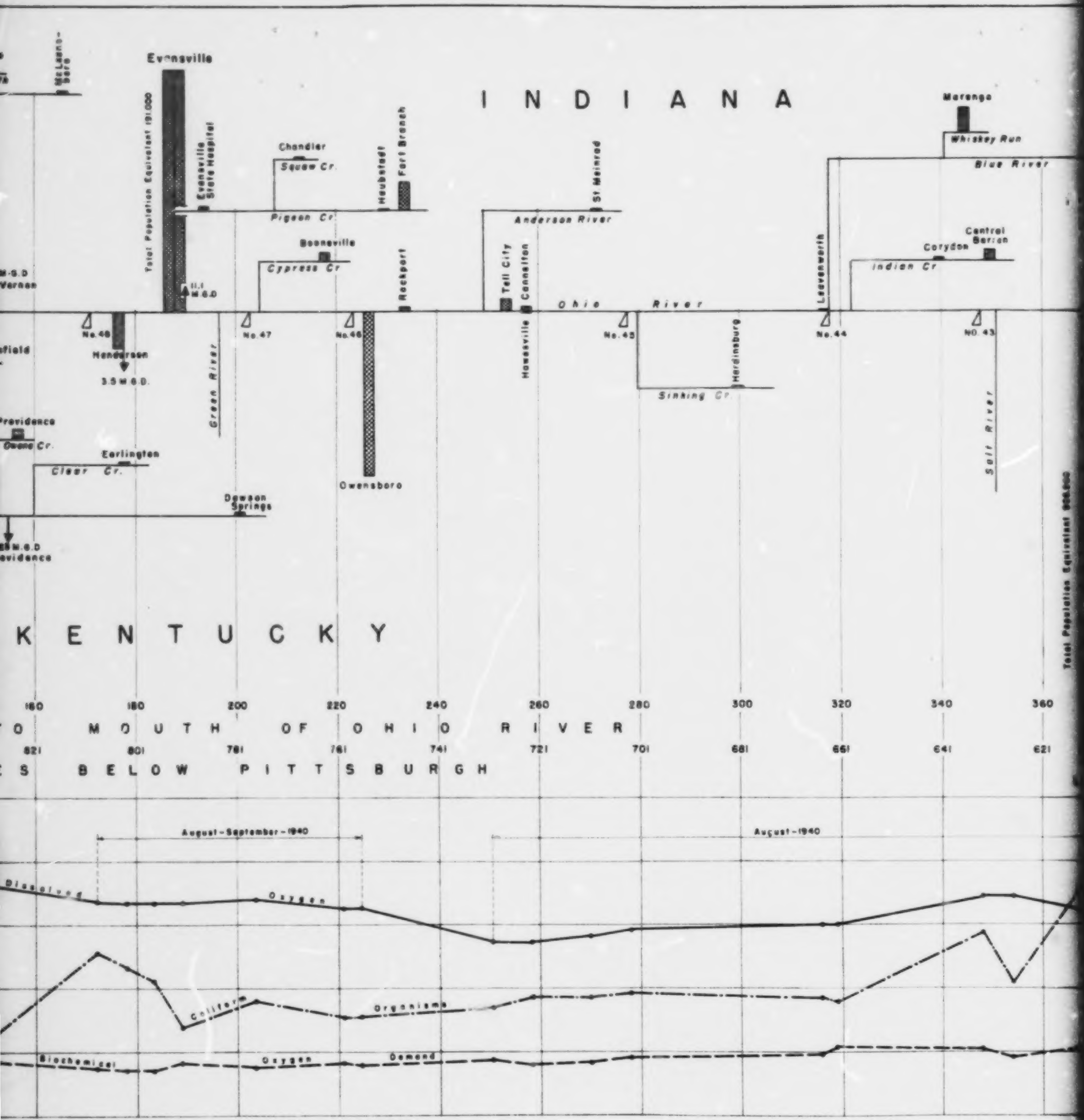
OHIO RIVER
HUNTINGTON TO LOUISVILLE
SOURCES OF POLLUTION
AND
SELECTED LABORATORY DATA

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

90-B



OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941



LEGEND

△ Navigation Dam

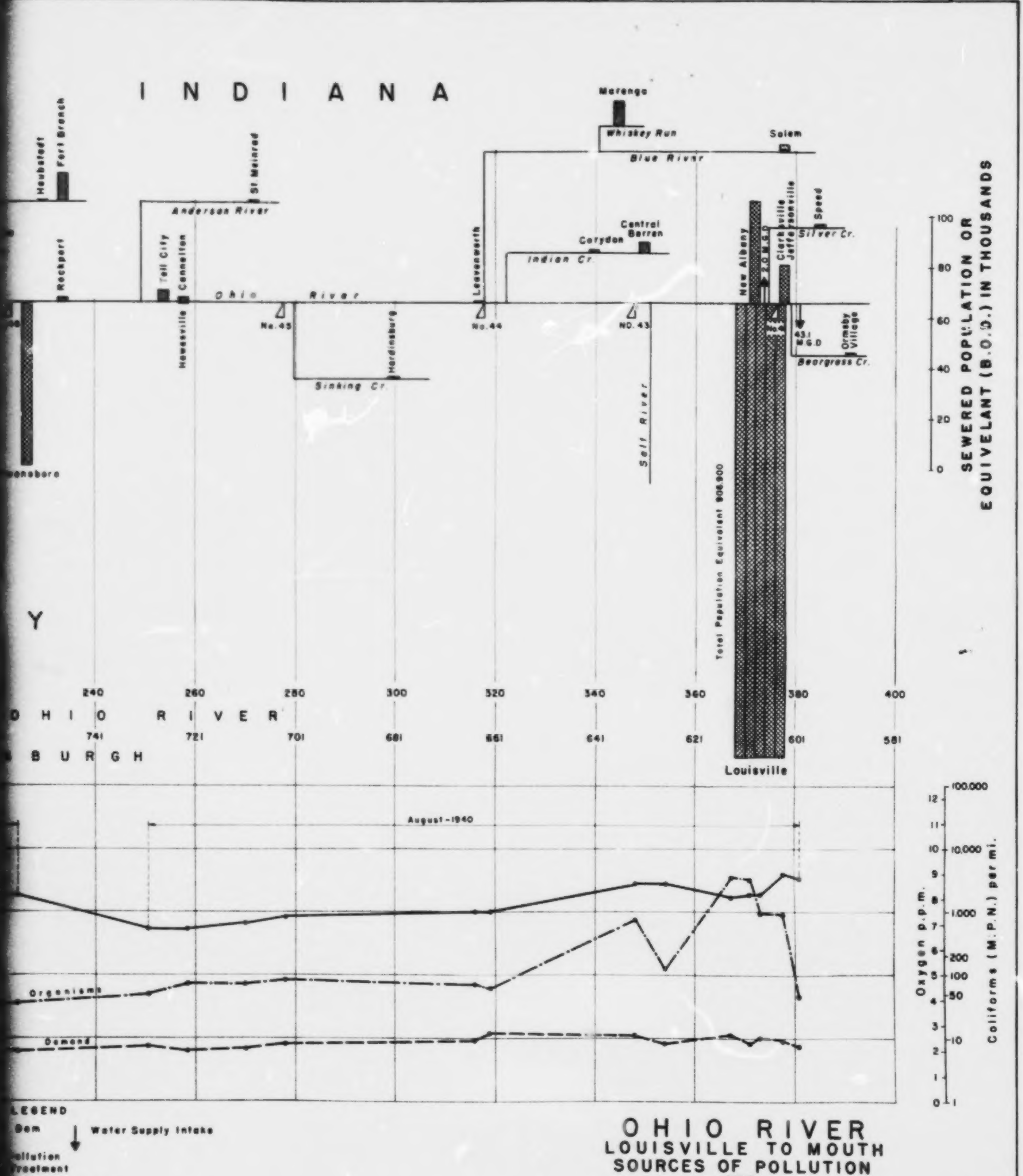
↓ Water Supply Intake

▮ —Indicates Pollution removed by Treatment

OHIO
LOUISVIL
SOURCES O

SELECTED LA

Fig. Oh-6



OHIO RIVER
LOUISVILLE TO MOUTH
SOURCES OF POLLUTION
AND
SELECTED LABORATORY DATA

90-C

Table Oh-4 Main Ohio River - Summary of Industrial Wastes Discharged to the Stream.

Industry	Number of Plants	Industrial Waste Disposal		At Least Minor Corrective Measures Taken	Estimated Sewered Population Equivalent (B.O.D.)
		Munic. Sewers	Private Outlets		
Canning	14	10	4	2	42,500
Meat	52	32	20	32	118,200
Milk	41	38	3	2	16,900
Brewing	13	13	-	13	103,200
Distilling	24	14	10	11	588,700
Tanning	3	2	1	-	21,600
Textile	10	8	2	3	44,400
Paper	6	2	4	3	19,900
Chemical	10	4	6	7	67,300
Oil Refining	12	2	10	11	46,100
By-product coke	8	1	7	7	234,000
Steel	62	3	59	15	-
Miscellaneous	59	28	31	19	31,800
Subtotal	314	157	157	125	1,334,600
Industrial Wastes to Cincinnati Sewers (1)					1,057,400
Total Industrial Waste Load - Ohio River					2,392,000

(1) Industries not surveyed individually. Population equivalent based on comprehensive sewer gaging and sampling program of city.

Presentation of Laboratory Data

Laboratory data on the main Ohio River are summarized in tables as follows:

Table Oh-5	Seasonal Average Results
Table Oh-5A	Frequency in Designated Ranges
Table Oh-5B	Average Phenol Results
Table Oh-7	Monthly Average Results
Table Oh-7A	Acid Stream Results

Stream samples were collected from February, 1939, to March, 1941, and examined at the Cincinnati laboratory, the laboratory boat Kiski, and mobile laboratory units. The following schedule shows the periods during which samples were collected on the various stream sections and the laboratories at which the samples were examined:

Pittsburgh to Dam 13	- Oct.-Dec., 1940 (K); May,1940,-March,1941 (M)
Dam 14 - Dam 23	- May-Sept.,1940 (K); Jan.-March,1941(K)
Pt.Pleasant - Dam 32	- June,1939,-April,1940 (K); April,1940 (M)
Dam 33 - Dam 39	- Feb.,1939-April,1940 (C)
Dam 39 - Mouth	- June,1940,-March,1941 (M)

Pittsburgh to Huntington

The Ohio River was at low or moderate stages during the entire period from May, 1940, to March, 1941. Consequently good high water observations are not available for the section above the mouth of the Kanawha River at Point Pleasant.

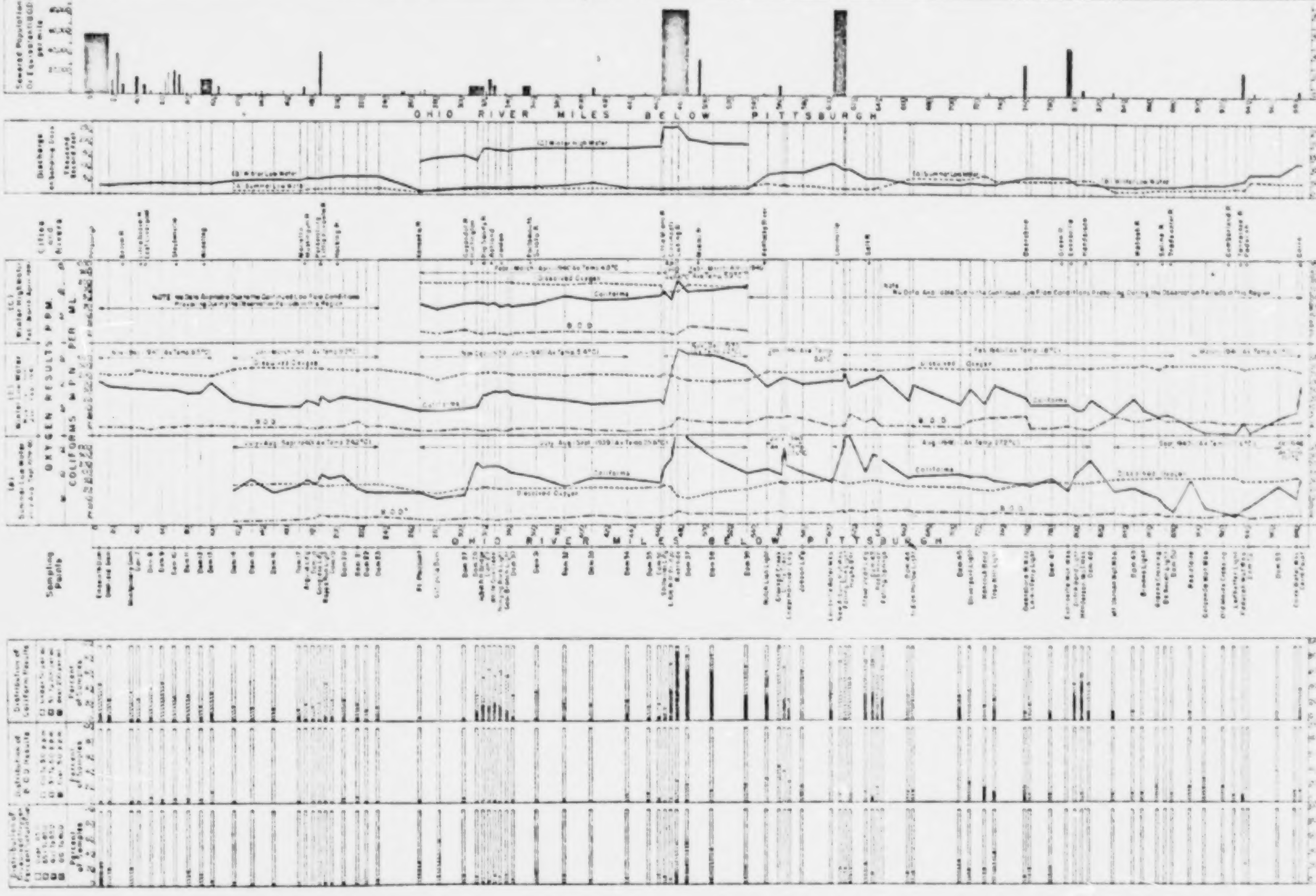
Figures Oh-8, Oh-9 and Oh-10 show the most unfavorable monthly average coliform, dissolved oxygen and B.O.D. results respectively, as found by this survey.

Figure Oh-7 shows group distribution and seasonal averages of coliform, oxygen demand and dissolved oxygen results at each of the Ohio River stations from Pittsburgh to the mouth for the entire period of the survey. Table Oh-5 shows seasonal averages of laboratory results at these same stations. In Figure Oh-11 variations in coliform, dissolved oxygen and oxygen demand results during the sampling period are shown for four sampling stations between Pittsburgh and Huntington. The generally high dissolved oxygen and low oxygen demands in the river as well as the more sensitive changes in the coliform content throughout the survey period are shown by these charts. A marked dissolved oxygen depression is noted at Emsworth Dam in October.

Fig. Oh-7

OHIO RIVER LABORATORY RESUTS

SEASONAL AVERAGES AND DISTRIBUTION OF RESULTS



OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

Acid stream conditions were observed in the river above Marietta, Ohio, during the summer and fall months when volumes of discharge were low. A summary of the acid results is included in Table Oh-7A. Acid doubtless influenced the laboratory results at times in the upper portion of the river. The effects of the highly acid Monongahela upon the Ohio immediately below its junction with the Allegheny are shown below. The extremely large decrease in coliforms and oxygen demand at Emsworth in October, as compared with November and December, when the acid concentrations were lower, suggests the effect of acid upon the bacterial concentrations in the river.

Station	Miles From Point Bridge Pitts.	Disch. c.f.s.	pH	Temp.	Quantity Units*			Flow Time (Hrs)
					D.O.	B.O.D.	Coli-forms	
October - 1940								
Allegheny	1.7	2,900	6.2	16.6	10.72	13.33	1690	
Monongahela	.5	2,710	4.0	18.6	11.38	5.69	181	
Totals	-	5,610	-	-	22.10	19.02	1871	
Emsworth	6.	5,460	5.6	16.3	21.80	6.0	66	52.8
Dashield	13.5	5,710	6.6	16.0	44.5	6.3	57	39.03
November - 1940								
Allegheny	1.7	10,600	7.0	9.6	110.	28.6	4820	
Monongahela	.5	14,500	5.6	11.6	127.6	36.2	377	
Totals	-	25,100	-	-	237.6	64.8	5197	
Emsworth	6.	23,660	6.2	9.0	244	47.3	2510	14.18
Dashield	13.5	23,270	6.3	8.3	256	51.1	2164	11.96
December - 1940								
Allegheny	1.7	31,200	6.7	1.3	477	53	1248	
Monongahela	.5	21,800	6.3	4.0	257	45.8	131	
Totals	-	53,000	-	-	734	98.8	1379	
Emsworth	6.	51,350	6.7	4.4	755	92.4	10680	6.26
Dashield	13.5	51,070	6.6	3.8	705	102.0	5362	5.83

* Quantity units = Concentration X discharge in thousand second feet.

Table Oh-5 Main Ohio River Laboratory Results - Seasonal Averages.

Station	Miles Below Pittsburgh	Summer Low Water Results					Winter Low Water Results					Winter High Water Results				
		Date	Temp. °C	Oxygen Results p.p.m.		Coliforms MPN/ml.	Date	Temp. °C	Oxygen Results p.p.m.		Coliforms MPN/ml.	Date	Temp. °C	Oxygen Results p.p.m.		Coliforms MPN/ml.
				D.O.	B.O.D.				D.O.	B.O.D.				D.O.	B.O.D.	
Emsworth Dam	6.	(Nov. & Dec. 1940)					(January & March 1941)	6.7	12.5	1.8	157					
Dashield Dam	13.5							6.0	12.2	1.8	99					
Montgomery Dam	31.7							6.0	12.4	1.8	80					
Dam #7	36.5							6.0	13.2	1.8	75					
" #8	46.4							6.3	12.8	1.4	71					
" #9	56.1							6.2	12.6	1.8	66					
" #10	66.0							6.8	12.5	1.8	63					
" #11	77.0							6.8	12.4	2.1	51					
" #12	87.5							7.1	12.2	2.0	58					
" #13	96.							6.8	12.1	2.1	135					
" #14	114.	(July-Sept. 1940)	23.7	8.0	0.8	24		2.8	13.4	2.0	24					
" #15	129.		23.9	8.2	0.8	68		2.6	13.7	1.8	19					
" #16	146.5		23.8	8.3	1.0	18		2.9	13.7	1.8	14					
" #17	167.5		24.6	8.2	1.1	35		1.9	13.6	1.9	14					
Argand Landing	173.5		24.8	8.3	1.3	64		2.0	13.6	1.7	27					
Dam #18	180.		24.6	8.2	1.5	47		2.0	13.6	1.6	22					
Congress Landing	183.		24.8	8.0	1.9	55		2.0	13.6	1.6	18					
Rapps Run Light	185.		24.8	7.9	2.0	111		1.9	13.6	1.8	39					
Dam #19	192.		24.7	8.0	1.7	66		3.0	13.4	1.8	24					
" #20	202.5		24.2	8.1	1.8	96		2.4	13.4	2.0	35					
" #21	214.5		23.9	8.1	1.5	30		2.6	13.2	3.0	30					
" #22	221.0		23.4	8.1	1.5	21		3.0	13.4	1.9	30					
" #23	231.5		24.2	8.2	1.6	20		3.1	13.4	2.0	24					
Point Pleasant	265.		24.9	6.6	1.2	18	(Nov. & Dec. 1939; January 1940)	5.1	12.3	1.0	10	(February-April 1940)	5.3	12.2	2.3	30
Gallipolis Dam	279.		24.8	6.3	1.0	12		6.6	11.2	1.0	10		4.7	12.2	2.0	22
Dam #27	301.	(July-September, 1939)	25.9	7.4	1.3	15		5.7	12.5	1.3	12		4.9	12.1	2.0	33
" #28	312.		25.8	7.3	1.4	337		5.3	12.5	1.1	15		5.0	12.[illegible]	2.0	44
N. & W. R.R. Bridge	316.		25.6	7.6	1.0	190		5.2	12.6	1.0	40		4.6	12.1	1.9	41
Dam #29	320.		25.7	7.6	1.1	216		5.3	12.6	1.1	47		4.6	12.1	2.0	38
White Oak Creek	326.		25.7	7.4	1.0	229		5.6	12.7	1.2	62		4.7	12.1	2.1	50
Hanging Rock Light	330.		25.6	7.4	1.0	222		5.5	12.6	1.0	57		4.6	12.1	1.9	32
Coal Branch Light	337.		25.5	7.3	1.2	148		5.2	12.5	1.0	59		4.6	12.2	1.7	42
Dam #30	339.		26.0	7.4	1.2	117		5.5	12.4	1.3	49		4.9	12.0	2.0	40
" #31	359.		24.8	7.3	1.3	87		4.7	12.3	1.5	35		4.7	11.9	2.2	52
" #32	383.		25.7	7.3	1.4	32		5.4	12.1	1.5	28		5.2	11.7	2.4	69
" #33	405.		25.6	7.5	1.8	80		5.4	12.3	1.2	17		5.0	12.0	2.2	53
" #34	434		25.1	7.3	1.4	73		4.6	12.2	0.9	22		4.5	11.7	2.2	56
" #35	451.		-	-	-	-		-	-	-	-		-	-	-	-
" #36	461.		24.4	7.5	1.4	48	(Nov. & Dec. 1939)	7.0	11.8	1.2	31		4.5	11.6	2.1	70
Stillwater Landing	462.8		25.9	7.8	1.5	162		7.6	12.2	1.4	17	Apr. '40	5.5	10.3	2.1	100
L. & N. R.R. Bridge	469.5		25.7	7.5	1.7	437		7.8	12.1	1.8	236		8.7	10.4	1.8	56
Riverside	475.		25.7	5.6	2.5	13337		7.7	11.5	3.5	2,895		8.7	10.4	2.0	402
Dam #37	483.		26.0	5.2	2.1	2901		7.2	11.0	3.0	1,840	Feb. & April 1940	5.9	11.5	3.2	111
" #38	503.		25.3	6.3	2.1	481		6.8	10.8	2.5	1,670		5.4	11.4	3.0	121
" #39	531.7		25.9	7.0	2.0	103		7.4	11.0	2.3	540		6.4	10.8	2.4	187
Notch Lick Light	547.8	(July 1940)	26.6	7.5	2.2	186	(January 1941)	3.9	12.7	3.5	87					
Crooked Cr.(Upper Light)	559.5		29.0	8.5	2.6	94		-	-	-	-					
Clifty Cr.(Lower Light)	561.		26.1	7.9	2.2	1260		3.4	12.5	3.4	199					
Lower Hanover Landing	562.6		29.0	8.3	2.1	218		3.3	12.5	3.5	60					
Jobson Landing Light	576.1		27.3	8.3	2.2	113		3.1	12.6	3.2	108					
Louisville Waterworks	600.	(August 1940)	29.0	8.8	2.2	44	(February 1941)	2.6	12.6	1.6	143					
New Albany "	608.5		28.4	8.2	2.6	997		2.0	13.1	1.7	142					
Falling Run Light	610.		28.8	8.2	2.3	3220		2.1	13.0	1.8	258					
Hughes Bar (Upper Light)	614.		28.3	8.1	2.6	3480		2.1	13.1	4.2	87					
Steve Green Ldg. Light	627.		28.8	8.6	2.3	105		1.2	12.9	2.5	141					
Dam #43	633.2		28.6	8.6	2.6	740		1.6	13.0	3.2	153					
Rock Haven (Upper Light)	637.		-	-	-	-		1.6	12.8	2.4	195					
Falling Spg.(Lower Light)	639.		-	-	-	-		1.6	12.9	1.6	246					
Dam #44	662.		26.5	7.5	2.7	63		3.9	13.0	1.8	23					
Indian Hollow Light	665.		27.2	7.5	2.4	73		3.7	13.3	1.7	96					
Dam #45	703.		27.2	7.3	2.3	90		3.7	13.1	1.5	16					
Cloverport Light	711.		26.8	7.0	2.1	78		2.1	13.1	2.6	65					
Hancock Bend Light	722.7		27.0	6.8	2.0	78		2.1	13.1	3.0	14					
Troy Hill Light	730.6		27.8	6.8	2.2	51		2.2	13.1	3.3	96					
Owensboro Waterworks	756.5		25.7	8.1	2.0	37		1.0	13.1	3.6	29					
Larkin Ferry Light	760.		25.7	8.1	2.1	35		0.5	13.4	1.1	16					
Dam #47	777.7		25.8	5.4	1.9	66		1.1	13.4	1.2	17					
Evansville Waterworks	791.		25.9	8.3	2.1	22		0.8	13.4	1.7	16					
Dutch Bend Light	797.7		26.5	8.3	1.7	106		0.8	13.4	1.3	9					
Henderson Waterworks	803.		26.5	8.2	1.7	199		0.8	13.4	1.1	9					
Dam #48	809.		26.4	8.3	1.9	356		0.8	13.3	1.1	24					
Mt. Vernon Waterworks	829.1	(September 1940)	23.2	9.0	2.1	19		2.3	13.6	3.7	6					
Dam #49	845.		24.0	9.1	1.7	29		2.1	13.6	2.7	28					
Browns Island Light	852.		24.1	9.2	2.0	19		2.0	13.9	2.8	8					
Greens Crossing(Up.Light)	865.		23.3	9.2	2.0	11		1.8	13.1	3.4	5					
DeKoven Light	873.7		23.3	9.3	1.5	5		1.8	13.9	2.7	6					
Dam #50	876.8		23.1	9.2	1.6	3		1.8	13.8	2.8	5					
Rosiclaire	891.6		21.2	9.2	2.0	62		2.8	13.8	2.1	2					
Golconda Waterworks	902.5		21.5	9.3	1.8	4	(March 1941)	2.7	13.8	2.7	1					
Old Maids Crossing Light	918.		21.1	9.3	1.8	3		3.1	13.8	2.2	1					
Ledbetter Light	927.3		21.7	9.3	1.8	2		3.2	13.7	2.1	1					
Paducah Waterworks	934.3		22.4	8.5	1.6	4		6.3	13.1	2.1	3					
Dam #52	933.9		22.6	8.6	1.2	5		4.8	13.4	2.1	1					
" #53	962.6		22.6	8.7	1.6	37		4.6	13.6	2.0	4					
Cairo Waterworks	978.0	Oct. 1940	19.8	9.4	1.7	11		5.0	12.8	2.4	7					
Cairo Point	981.		19.6	8.9	1.7	89		4.2	12.6	2.4	102					

Table No. Oh-5A Number and Percentage of Samples at Points on Main Ohio River Showing Coliform Numbers, Dissolved Oxygen and 5-Day B.O.D. within Designated Ranges.

Station	Miles from Pitts-burgh	Coliform Organisms per ml.							Dissolved Oxygen-Percent Saturation									5-Day B.O.D.-P.P.M.						
		No. Sam-ples	0-50		51-200		Over 200		No. Sam-ples	Over 85		65.1-85		40.1-65		0-40		No. Sam-ples	0-3		3.1-5		Over 5	
			No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%
Emsworth Dam	6.	39	19	49	16	41	4	10	39	26	67	2	5	5	13	6	15	39	38	97	1	3	0	0
Dashield Dam	13.5	39	27	69	9	23	3	8	39	29	74	10	26	0	0	0	0	39	38	97	1	3	0	0
Montgomery Dam	31.7	39	23	59	15	38	1	3	39	29	74	10	26	0	0	0	0	39	38	97	1	3	0	0
Dam #7	36.5	32	22	69	9	28	1	3	32	32	100	0	0	0	0	0	0	32	31	97	1	3	0	0
" #8	46.4	37	20	54	15	41	2	5	37	37	100	0	0	0	0	0	0	37	34	92	3	8	0	0
" #9	56.1	32	15	47	17	53	-	-	32	32	100	0	0	0	0	0	0	32	30	94	2	6	0	0
" #10	66.0	41	27	66	13	32	1	2	41	41	100	0	0	0	0	0	0	41	38	93	3	7	0	0
" #11	77.0	41	26	63	13	32	2	5	41	33	80	8	20	0	0	0	0	41	38	93	2	5	1	2
" #12	87.5	35	28	80	5	14	2	6	35	29	83	6	17	0	0	0	0	35	33	94	2	6	0	0
" #13	96.	41	21	51	16	39	4	10	41	38	93	3	7	0	0	0	0	40	34	85	6	15	0	0
" #14	114.	65	52	80	12	18	1	2	65	62	95	3	5	0	0	0	0	65	64	98	1	2	0	0
" #15	129.	65	53	82	10	15	2	3	65	63	97	2	3	0	0	0	0	65	65	100	0	0	0	0
" #16	146.5	65	54	83	11	17	-	-	65	63	97	2	3	0	0	0	0	65	65	100	0	0	0	0
" #17	167.5	64	54	84	7	11	3	5	64	61	95	3	5	0	0	0	0	64	63	98	1	2	0	0
Argand Landing	175.5	64	49	77	13	20	2	3	64	64	100	0	0	0	0	0	0	64	64	100	0	0	0	0
Dam #18	180.	63	51	81	10	16	2	3	63	63	100	0	0	0	0	0	0	63	62	98	1	2	0	0
Congress Landing	183.	59	44	75	13	22	2	3	59	57	97	2	3	0	0	0	0	59	58	98	1	2	0	0
Rapps Run Light	185.	59	29	49	26	44	4	7	59	57	97	2	3	0	0	0	0	59	57	97	2	3	0	0
Dam #19	192.	65	46	69	15	25	4	6	64	62	96	2	4	0	0	0	0	65	64	98	0	0	1	2
" #20	202.5	65	45	69	16	25	4	6	64	62	97	2	3	0	0	0	0	65	61	94	4	6	0	0
" #21	214.5	66	50	76	12	18	4	6	65	61	94	4	6	0	0	0	0	66	60	91	5	8	1	1
" #22	221.0	65	54	83	10	15	1	2	64	59	92	5	8	0	0	0	0	65	64	98	1	2	0	0
" #23	231.5	63	51	81	11	17	1	2	62	57	92	5	8	0	0	0	0	63	62	98	1	2	0	0
Point Pleasant	265.	54	51	94	3	6	-	-	54	37	69	17	31	0	0	0	0	54	52	96	1	2	1	2
Gallipolis Dam	279.	63	63	100	-	-	-	-	62	26	42	36	58	0	0	0	0	63	63	100	0	0	0	0
Dam #27	301.	68	65	96	3	4	-	-	68	60	88	8	12	0	0	0	0	68	64	94	3	4	1	2
" #28	312.	69	44	64	15	22	10	14	70	63	90	7	10	0	0	0	0	70	69	99	1	1	0	0
N. & W. R.R. Bridge	316.	96	40	42	35	36	21	22	97	95	98	2	2	0	0	0	0	97	94	97	3	3	0	0
Dam #29	320.	97	30	31	47	48	20	21	97	94	97	3	3	0	0	0	0	97	95	98	2	2	0	0
White Oak Creek	326.	94	38	40	32	34	24	26	94	83	88	11	12	0	0	0	0	94	92	98	1	1	1	1
Hanging Rock Light	330.	94	31	33	44	47	19	20	94	84	89	10	11	0	0	0	0	94	93	99	0	0	1	1
Coal Branch Light	337.	91	36	40	42	46	13	14	91	79	87	12	13	0	0	0	0	91	90	99	1	1	0	0
Dam #30	339.	66	42	64	20	30	4	6	68	63	93	5	7	0	0	0	0	68	66	97	2	3	0	0
" #31	359.	71	43	61	26	36	2	3	71	59	83	12	17	0	0	0	0	71	68	96	3	4	0	0
" #32	383.	67	51	76	13	20	3	4	67	58	87	9	13	0	0	0	0	65	61	94	4	6	0	0
" #33	436.	43	33	77	9	21	1	2	43	41	95	2	5	0	0	0	0	43	42	98	0	0	1	2
" #34	434.	73	53	72	13	16	7	10	72	66	92	6	8	0	0	0	0	73	65	89	7	10	1	1
" #35	451.	38	29	76	8	21	1	3	38	38	100	0	0	0	0	0	0	38	33	87	4	10	1	3
" #36	461.	132	102	77	22	17	8	6	129	112	87	17	13	0	0	0	0	132	126	95	5	4	1	1
Stillwater Landing	462.8	78	65	83	7	9	6	8	77	69	90	8	10	0	0	0	0	77	76	99	1	1	0	0
L. & N. R.R. Bridge	469.5	155	36	23	54	35	65	42	154	135	88	19	12	0	0	0	0	156	148	95	8	5	0	0
Riverside	475.	72	1	1	5	7	66	92	73	33	45	30	41	5	7	5	7	72	50	69	20	28	2	3
Dam #37	493.	147	19	13	31	21	97	66	135	80	59	34	25	15	11	6	5	147	110	75	32	22	5	3
" #38	533.	138	16	12	30	21	92	67	136	71	52	53	39	11	8	1	1	139	116	83	22	16	1	1
" #39	531.7	88	25	28	34	39	29	33	88	68	77	19	22	1	1	0	0	88	66	75	21	24	1	1
Notch Lick Light	547.8	9	3	33	3	34	3	33	9	9	100	0	0	0	0	0	0	9	6	67	3	33	0	0
Crooked Cr.(Upper Light)	559.5	2	-	-	2	100	-	-	2	2	100	0	0	0	0	0	0	2	1	50	1	50	0	0
Clifty Cr. (Lower Light)	561.	7	2	29	3	43	2	28	7	7	100	0	0	0	0	0	0	7	4	57	3	43	0	0
Lower Hanover Landing	562.6	7	5	71	1	15	1	14	7	7	100	0	0	0	0	0	0	7	5	71	2	29	0	0
Jobson Landing Light	576.1	9	3	33	6	67	-	-	9	9	100	0	0	0	0	0	0	9	7	78	2	22	0	0
Louisville Waterworks	600.	8	4	50	3	38	1	12	8	8	100	0	0	0	0	0	0	8	8	100	0	0	0	0
New Albany *	608.5	9	-	-	2	22	7	78	9	7	78	2	22	0	0	0	0	9	8	89	1	11	0	0
Falling Run Light	610.	9	-	-	1	11	8	89	9	7	78	2	22	0	0	0	0	9	9	100	0	0	0	0
Hughes Bar (Upper Light)	614.	9	-	-	4	44	5	56	9	7	78	2	22	0	0	0	0	9	8	89	0	0	1	11
Kosmosdale *	627.	14	3	21	6	43	5	36	14	10	71	4	29	0	0	0	0	14	12	86	2	14	0	0
Dam #43	633.2	14	3	21	6	43	5	36	14	12	86	2	14	0	0	0	0	14	13	93	0	0	1	7
Rock Haven (Upper Light)	637.	10	2	20	6	60	2	20	2	2	100	0	0	0	0	0	0	5	4	80	1	20	0	0
Falling Spg. (Lower Light)	639.	10	-	-	7	70	3	30	2	2	100	0	0	0	0	0	0	5	5	100	0	0	0	0
Dam #44	662.	6	4	67	2	33	-	-	6	5	83	1	17	0	0	0	0	6	5	83	1	17	0	0
Indian Hollow Light	665.	6	3	50	3	50	-	-	6	5	83	1	17	0	0	0	0	6	5	83	1	17	0	0
Dam #45	705.	6	4	67	1	17	1	16	6	4	67	2	33	0	0	0	0	6	6	100	0	0	0	0
Cloverport Light	711.	5	3	60	2	40	-	-	5	4	80	1	20	0	0	0	0	5	4	80	1	20	0	0
Hancock Bend Light	722.7	5	4	80	1	20	-	-	5	4	80	1	20	0	0	0	0	5	4	80	0	0	1	20
Troy Hill Light	730.6	7	5	71	1	15	1	14	7	4	57	3	43	0	0	0	0	7	6	86	0	0	1	14
Owensboro Waterworks	756.5	9	8	89	1	11	-	-	9	8	89	1	11	0	0	0	0	9	7	78	1	11	1	11
Larkin Ferry Light	760.	9	7	78	2	22	-	-	9	7	78	2	22	0	0	0	0	9	8	89	1	11	0	0
Dam #47	777.7	9	8	89	-	-	1	11	9	7	78	2	22	0	0	0	0	9	8	89	1	11	0	0
Evansville Waterworks	791.	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	9	100	0	0	0	0
Dutch Bend Light	797.7	8	4	50	1	12	3	38	8	8	100	0	0	0	0	0	0	8	8	100	0	0	0	0
Henderson Waterworks	803.	8	3	38	1	12	4	50	8	8	100	0	0	0	0	0	0	8	7	88	1	12	0	0
Dam #48	809.	8	4	50	3	38	1	12	8	8	100	0	0	0	0	0	0	8	8	100	0	0	0	0
Mt. Vernon Waterworks	829.1	8	7	88	-	-	1	12	8	8	100	0	0	0	0	0	0	8	7	88	1	12	0	0
Dam #49	845.	8	7	88	1	12	-	-	8	8	100	0	0	0	0	0	0	8	7	88	1	12	0	0
Browns Island Light	852.	8	8	100	-	-	-	-	8	8	100	0	0	0	0	0	0	8	7	88	1	12	0	0
Greens Crossing Light	865.	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	7	78	2	22	0	0
DeKoven Light	870.7	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	9	100	0	0	0	0
Dam #50	876.8	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	8	89	1	11	0	0
Rosiclaire Waterworks	891.6	9	8	89	-	-	1	11	9	9	100	0	0	0	0	0	0	9	7	78	2	22	0	0
Golconda Waterworks	902.5	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	6	67	3	33	0	0
Old Maids Crossing Light	918.	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	7	78	2	22	0	0
Ledbetter Light	927.3	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	8	89	1	11	0	0
Paducah Waterworks	934.3	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	8	89	0	0	1	11
Dam #52	938.9	9	9	100	-	-	-	-	9	9	100	0	0	0	0	0	0	9	9	100	0	0	0	0
" #53	962.6	9	8	89	1	11	-	-	9	9	100	0	0	0	0	0	0	9	9	100	0	0	0	0
Cairo Waterworks	978.0	7	7	100	-	-	-	-	7	7	100	0	0	0	0	0	0	7	6	86	1	14	0	0
Cairo Point	981.	7	4	57	2	29	1	14	7	7	100	0	0	0	0	0	0	7	6	86	1	14	0	0

* And Steve Green Landing.

Table Oh-5B Main Ohio River - Average Phenol Results

Sampling Point	Date 1940	Number Samples	Average Temperature °C.	Phenol p.p.b.
Emsworth Dam	Oct.	1	17.8	1.6
		7	16.2	**
	Nov.	5	9.1	4.0
		1	9.3	**
	Dec.	2	4.6	4.3
		2	3.8	**
Dashield Dam	Sept.	1	17.2	**
	Oct.	1	14.8	**
Montgomery Dam	Nov.	1	14.0	**
Dam #7	Sept.	1	19.5	**
	Oct.	1	13.5	**
	Nov.	1	7.0	1.0
Dam #8	Jan. (1941)	1	5.0	8.8
Dam #9	Oct.	1	17.5	**
	Nov.	2	6.8	**
	Dec.	1	3.0	4.4
Dam #10	Sept.	1	18.5	**
	Dec.	5	4.6	11.7
		1	5.7	**
	Jan. (1941)	1	5.7	17.6
Dam #11	Dec.	3	3.6	12.7
		1	5.7	**
Dam #13	Oct.	6	15.5	**
	Nov.	4	7.7	17.0
		2	8.5	**
	Dec.	7	4.7	17.8
	Jan. (1941)	1	5.2	12.8
Dam #14	May	6	15.4	8.5
		4	18.4	**
	June	9	22.5	**
	July	10	24.4	**
	Aug.	1	24.3	1.6
		10	25.2	**
	Sept.	4	22.2	**
Dam #15	May	1	13.0	6.4
Dam #16	June	1	18.2	**
Argand Landing	May	3	14.5	2.7
		2	19.6	**
	June	1	24.5	**
	July	2	23.8	**
	Aug.	2	27.0	**
	Sept.	2	23.8	**
Dam #22	May	1	11.7	2.1
		1	20.2	**
Dam #23	May	4	15.7	4.5
		4	16.8	**
	June	4	19.8	**
Pt. Pleasent	Feb.	2	2.5	2.6
	Mar.	1	5.0	3.8
	Apr.	1	7.0	11.5
Gallipolis Dam	Feb.	2	1.8	4.8
	Mar.	3	3.9	6.5
		3	3.2	**
	Apr.	1	8.0	**
Dams #27 & 28*	Feb.	1	1.7	22.8
		2	4.0	**
	Mar.	2	6.0	8.8
		2	7.0	**
Dam #29	Feb.	2	2.0	3.2
	Mar.	1	2.0	**
Dams #30 & 31*	Feb.	1	0.7	22.4
Dam #31	Feb.	1	1.8	16.0
Dam #32	Feb.	3	2.6	**
	Mar.	1	4.5	1.3
		5	4.0	**
	Apr.	1	8.0	**

* Composite samples. ** Less than 1.0.

The effects of phenol waste products upon the taste and odor problems of public water supplies are well known. Previous investigations have shown that tastes may be produced by phenols in excess of one part per billion and that waters containing more than ten parts per billion are not suitable for public use. Also phenolic wastes, if highly concentrated, have a toxic effect upon the biological life in the stream and hence retard natural purification processes. A summary of all phenol determinations made on the main Ohio River is shown on Table Oh-5B. Phenols in excess of 1 p.p.b. were observed in samples below East Liverpool, Steubenville and Wheeling in the colder months of November-December, 1940 and January, 1941 and at Pt. Pleasant and Gallipolis Dam in February, March and April, 1940. Phenols of from 2 to 8 p.p.b. were observed at Dams 14, 15, 22 and 23 in May, 1940. The results seem to indicate intermittent discharge of phenolic wastes. There is also some indication that temperature plays an important part in the persistence of these wastes in the stream, more rapid disappearance being observed during the warmer months.

Oxygen conditions in the Pittsburgh-Huntington stretch of the Ohio River at the time of sampling were generally good, the large majority of samples having oxygen demands of less than 3. parts per million and dissolved oxygen contents of more than 6.5 p.p.m. Coliform results on the other hand show a relatively high concentration, counts in excess of 200 per ml. being recorded at time at all stations except the three just above Huntington.

The heaviest pollution occurred below Pittsburgh, Wheeling and Parkersburg. Evidence of natural purification was observed in the 53 mile section between Dams 14 and 17 and in the 70 miles between Dams 23 and 27. Reductions in number of coliform bacteria and in oxygen demand were noted in these stretches during the periods of sampling. The percentage of total number of samples showing less than 50 coliforms per ml. increased from 51 to 84 percent between Dams 13 and 17 and from 81 to 96 percent between Dams 23 and 27.

Seven major tributaries enter the Ohio between Pittsburgh and Huntington including the Allegheny and Monongahela Rivers which join to form the Ohio. In order, proceeding downstream, the other streams are the Beaver, Muskingum, Little Kanawha, Hocking and Kanawha Rivers. Comparing the results at stations above and below these tributaries little, if any, effect was noted on the Ohio at the time of sampling, except as noted above at the junction of the Allegheny and the Monongahela.

Fig. Oh-8

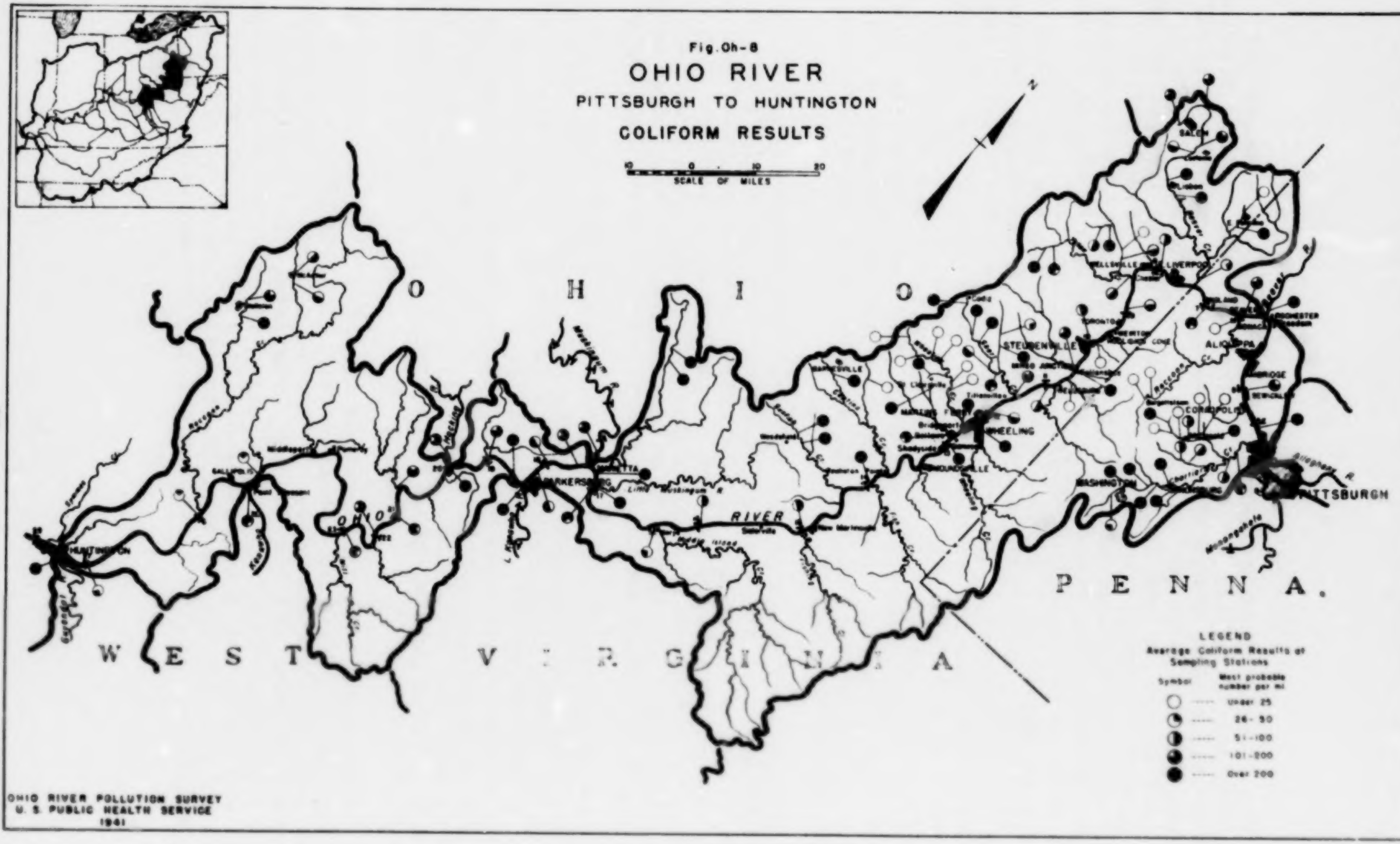

N
SCALE OF MILES
10
0
10
20
OHIO
PENNA.
WEST VIRGINIA
RIVER
OHIO R.
SALEM
LIVERPOOL
WELLSVILLE
ROCHESTER
ALIQUIPPA
AMBRIDGE
CORAOPOLIS
PITTSBURGH
Allegheny R.
Monongahela
STEUBENVILLE
WEIRTON
WHEELING
MOUNDSVILLE
WASHINGTON
MARIETTA
PARKERSBURG
Little Muskingum R.
GALLIPOLIS
Kanawha
HUNTINGTON
LEGEND
Average Coliform Results at Sampling Stations
Symbol
Most probable number per ml
○ ----- Under 25
◔ ----- 26-50
◑ ----- 51-100
◕ ----- 101-200
● ----- Over 200

Fig. Oh-8

OHIO RIVER

PITTSBURGH TO HUNTINGTON

COLIFORM RESULTS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig. Oh-9

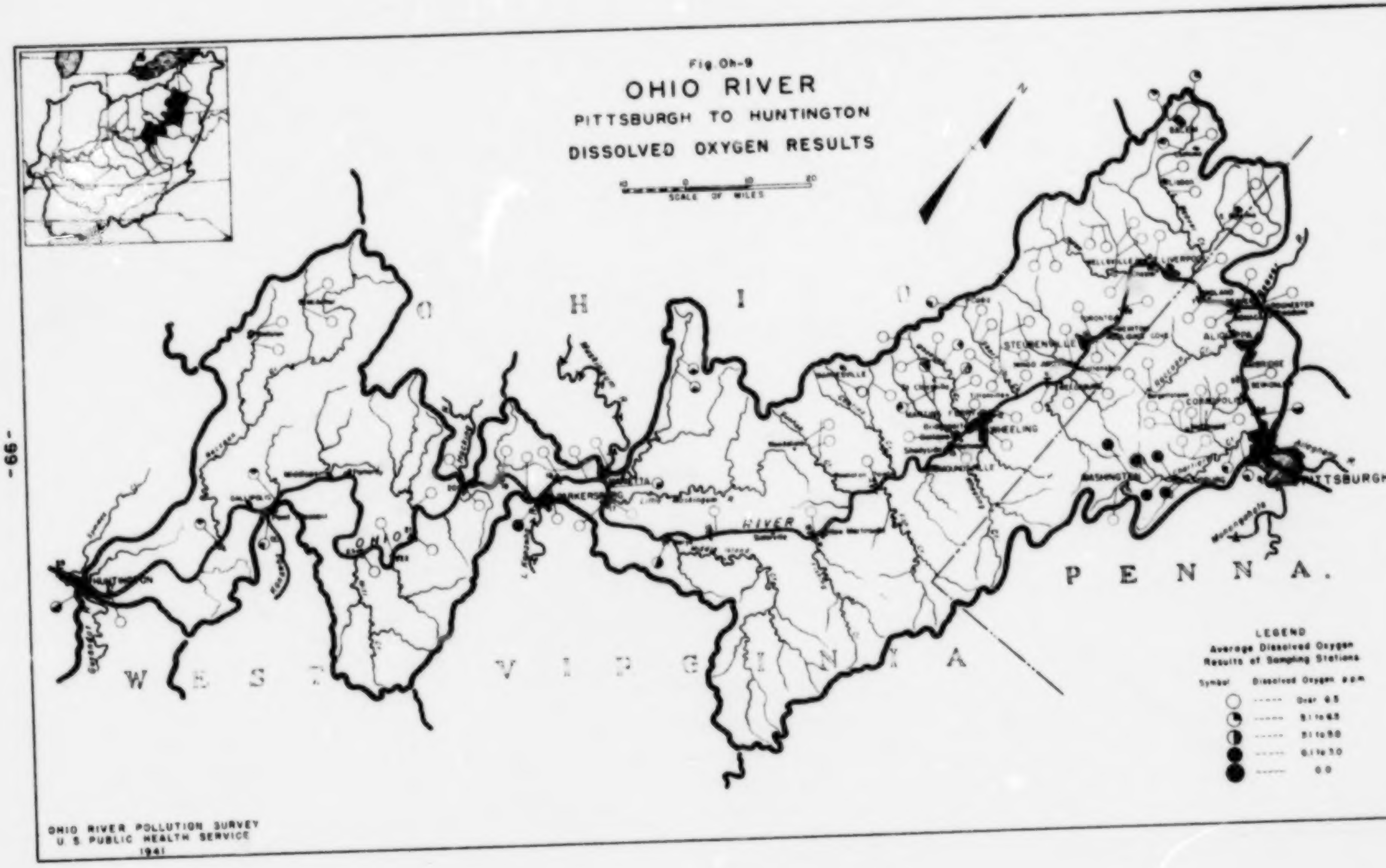

N
SCALE OF MILES
10
0
10
20
O H I O
W E S T V I R G I N I A
P E N N A.
PITTSBURGH
WHEELING
STEUBENVILLE
HUNTINGTON
OHIO
RIVER
LEGEND
Average Dissolved Oxygen
Results of Sampling Stations
Symbol
Dissolved Oxygen p.p.m.
○ Over 6.5
◔ 5.1 to 6.5
◑ 3.1 to 5.0
● 0.1 to 3.0
● 0.0

Fig. Oh-9

OHIO RIVER
PITTSBURGH TO HUNTINGTON
DISSOLVED OXYGEN RESULTS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig. Oh-10

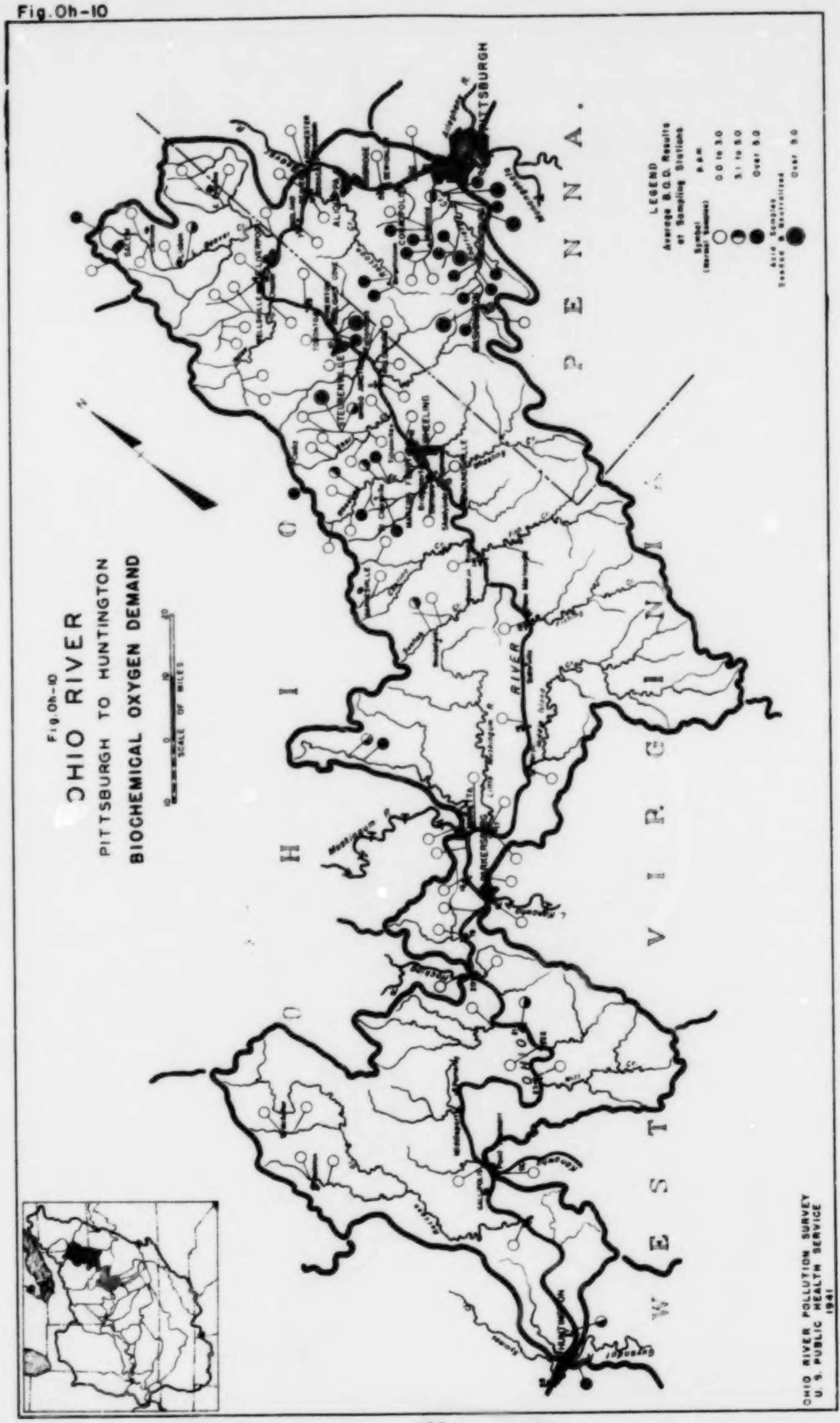
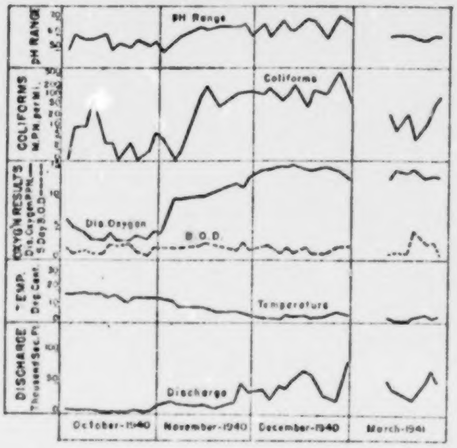


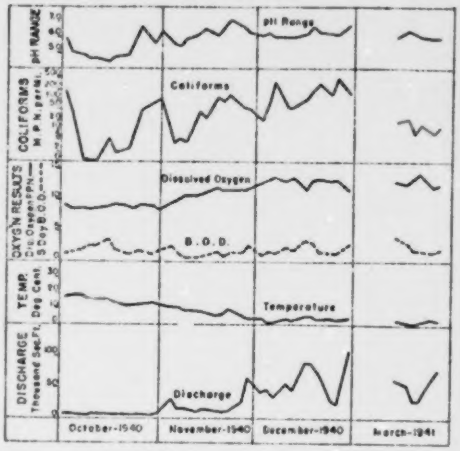
Fig. Oh-10
OHIO RIVER
PITTSBURGH TO HUNTINGTON
BIOCHEMICAL OXYGEN DEMAND
10 0 10 20
SCALE OF MILES
OHIO
PENNA.
WEST VIRGINIA
PITTSBURGH
WHEELING
STEUBENVILLE
RIVER
HUNTINGTON
LEGEND
Average B.O.D. Results
at Sampling Stations
Symbol (Normal Samples)
p.p.m.
○ 0.0 to 3.0
◐ 3.1 to 5.0
● Over 5.0
Acid Samples Seeded & Neutralized
● Over 5.0
OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

OHIO RIVER LABORATORY RESULTS
AT INDIVIDUAL STATIONS

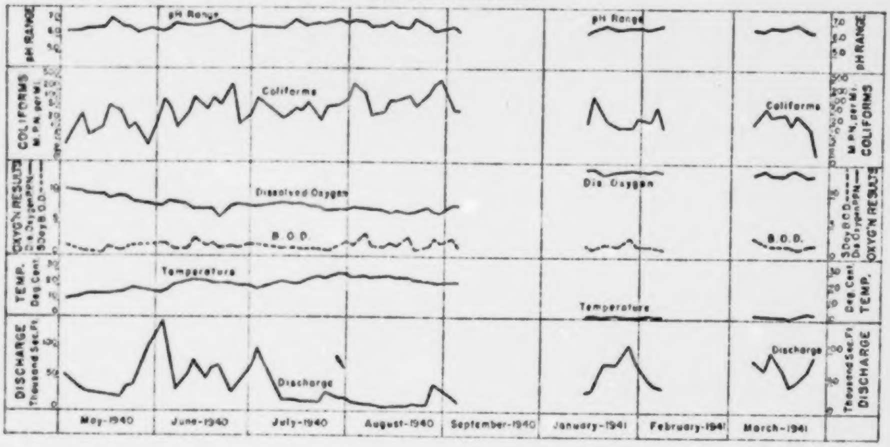
EMSWORTH DAM (STA.-6.0)
BELOW PITTSBURGH



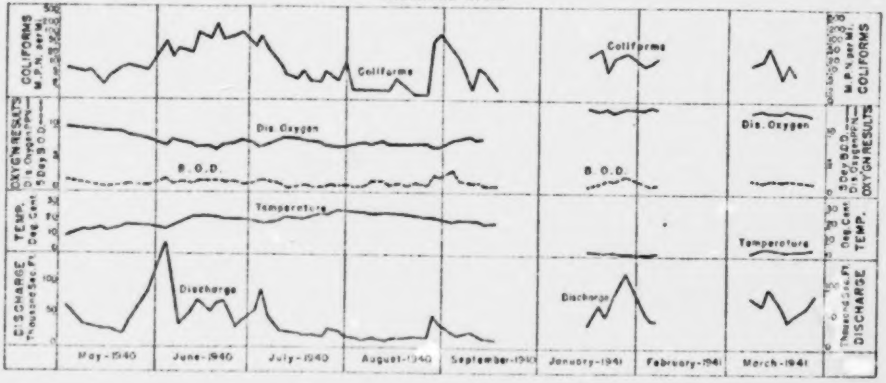
DAM No.13 (STA.-96.0)
BELOW WHEELING



RAPPS RUN LIGHT (STA.-185.0)
BELOW PARKERSBURG



DAM No.23 (STA.-231.5)
MILLWOOD W. VA.



100-A

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

Fig. Oh-11

The findings of the laboratory survey of this section may be summarized briefly as follows:

(1) Zones of pollution were observed in the Pittsburgh-Wheeling area and below Parkersburg.

(2) Definite zones of recovery due to natural purification were observed between Dams 14 and 17 and Dams 23 and 27.

(3) Acid conditions were found during low flows in the Ohio River as far downstream as Dam 17.

(4) Because of acid concentration, the measurable effect of sewage and organic industrial pollution below Pittsburgh and Wheeling was less than otherwise would be expected, although relatively high densities of coliform bacteria were observed at some points.

(5) Relatively high concentrations of taste-producing phenols were observed at various points throughout the entire section, especially during the cooler months. Evidence of progressive diminution in these concentrations was noted during the warmer months.

(6) With the exception of the Allegheny and Monongahela Rivers the sanitary quality of the water of the major tributary streams, at their mouths was as good or better than that of the main stream and the inflow had little or no effect on the main stream during the time of the present investigation. The tributaries were more alkaline than the Ohio River and tended to reduce the acidity or increase the alkalinity of the main stream.

Huntington to Cincinnati

This section of the river is characterized by a succession of small cities in the 50 mile stretch from Huntington to Portsmouth and a relatively sparsely settled valley in the 100 miles between Portsmouth and Cincinnati. Three major tributaries enter the Ohio in this stretch, the Guyandot, the Big Sandy and the Scioto. Ashland, Ironton and Portsmouth take their water supplies from the river in the upper portion of this section and Cincinnati, Covington and Newport from the extreme lower end. The major sanitary problem in the Huntington-Cincinnati area is one of high bacterial pollution affecting the quality of the raw water used for public supplies. (See Figure Oh-7 and Table Oh-5A). At Dam 29 (Mile 320 below Pittsburgh)

21 percent of the samples showed coliform counts in excess of 200 per ml. and above Ironton (Mile 326 below Pittsburgh) 26 percent of the samples were in this group during the sampling period of this survey. At Dam 36 just above Cincinnati counts were over 200 per ml. 6 percent of the time of sampling and were less than 50 per ml. 77 percent of this time.

The dissolved oxygen results were generally good in this area with saturation values of 85 percent or higher at all sampling stations during most of the period of observation. The oxygen demand averages were low, rarely exceeding 2.0 p.p.m. and usually being about 1.0 p.p.m., except during high water periods when some increases were noted.

The most significant indication regarding the high degree of bacterial pollution in the Huntington-Portsmouth area is the evidence that the pollution is largely of local origin. High water results with increased velocities and shorter times of flow indicate only a moderate increase in coliform organisms above Huntington which might be attributed to upstream pollution. There is a tendency for the coliform counts to level off during the high water period in passing through this district, with the average maximum occurring at Dam 32 (See Figure 7 and Table 5). This figure also indicates the reduction in coliform bacteria between Dams 31 and 36 during low-water periods. There appears to be little recovery between Dams 32 and 36 during the high water period.

Phenol determinations made during the period from February to April are summarized on Table Oh-5B. Phenols in excess of 1 p.p.b. were present at all stations at some time during the sampling period. Maximum concentrations in excess of 20 p.p.b. were recorded at Dams 27, 28, 30 and 31.

All of the important tributary streams in this section of the Ohio had relatively high coliform counts during the June to October period. The Guyandot and Big Sandy samples were undoubtedly influenced by sewage from Huntington and Catlettsburg. Inflow from the Scioto increased the alkalinity of the Ohio River markedly. Comparing the results of observations at stations immediately above and below tributary streams, there do not appear to have been any marked changes in the sanitary quality of the Ohio River due to contributions of the tributaries during the period of sampling.

The observations in the Huntington-Cincinnati section of the river may be summarized briefly as follows:

(1) The Huntington-Cincinnati section of the main Ohio River is characterized by a considerable amount of pollution of local origin originating in the area from Huntington to Portsmouth.

(2) A zone of self-purification existed in the river from Portsmouth to Dam 36 during low-flow periods, which was not apparent during periods of high discharge.

(3) Phenols were present in the area from Dam 27 to Dam 32 during the colder months of the year.

(4) Tributaries entering this section were observed to have high coliform counts during the warmer months with lower concentrations in the cooler months of higher stream flow. The inflow of tributaries did not appear to cause any marked changes in the sanitary quality of the main stream.

Cincinnati to Louisville

This 118-mile section of the river receives a large amount of pollution at its upper end from the Cincinnati metropolitan area, and additional pollution from several minor sources between Cincinnati and Madison. In the 40-mile stretch between Madison and Louisville the river receives little or no pollution.

Four major tributaries enter the Ohio River in this section, the Little Miami, Licking, Miami and Kentucky Rivers. The Little Miami and Licking Rivers, receiving sewage from the Cincinnati area in their lower reaches, and the Miami River from upstream pollution, contributed appreciable pollution loads to the Ohio River. The Kentucky River appeared to be a relatively clean stream. The higher alkalinities of the Miami and Kentucky Rivers tended to increase somewhat the alkalinity of the main stream below their confluences.

More extensive laboratory observations were made in the section from Cincinnati to Dam 39, particularly in the Cincinnati pool, than in the lower end of this river section where observations were confined to three series of observations by mobile laboratory units in July-August and October, 1940, and January-February, 1941. For this reason the laboratory findings on these two parts of the river section are discussed separately.

The effects of pollution from the Cincinnati area on the upper portion of this section of the river are indicated as follows:

(1) Increases in maximum averages of coliform organisms ranging from about 2,000 to 60,000 per ml. at times of low flows and from 100 to 400 per ml. at times of high water.

(2) Decreases in dissolved oxygen below the city to minimum monthly average values of 3.8 to 5.4 p.p.m. with individual samples approaching total depletion in September, 1939. During the months of low water temeratures and in the summer months when river flows were high and open channel conditions existed, dissolved oxygen results in the Cincinnati area were satisfactory.

(3) Oxygen demand averages usually less than 3 p.p.m. with some individual results above 6 p.p.m. A shore line survey by the City of Cincinnati close to the many sewer outlets showed very high oxygen demand values in the immediate vicinity of these sources of pollution.

(4) Increases in dissolved oxygen to approximately 85 percent saturation and decreases in oxygen demand to between 2 and 3 p.p.m. occurred below Dam 37 with natural purification much more marked in the summer low-flow period than during high water - low temperature conditions. During high flows coliform organisms reached their maximum at Dam 38, moving upstream to Riverside below Mill Creek with higher water temperatures and lower flows. The following tabulation indicates the effect of stream flow and water temperatures on the location of the maximum concentration of coliform organisms below Cincinnati:

Fig. Oh-12

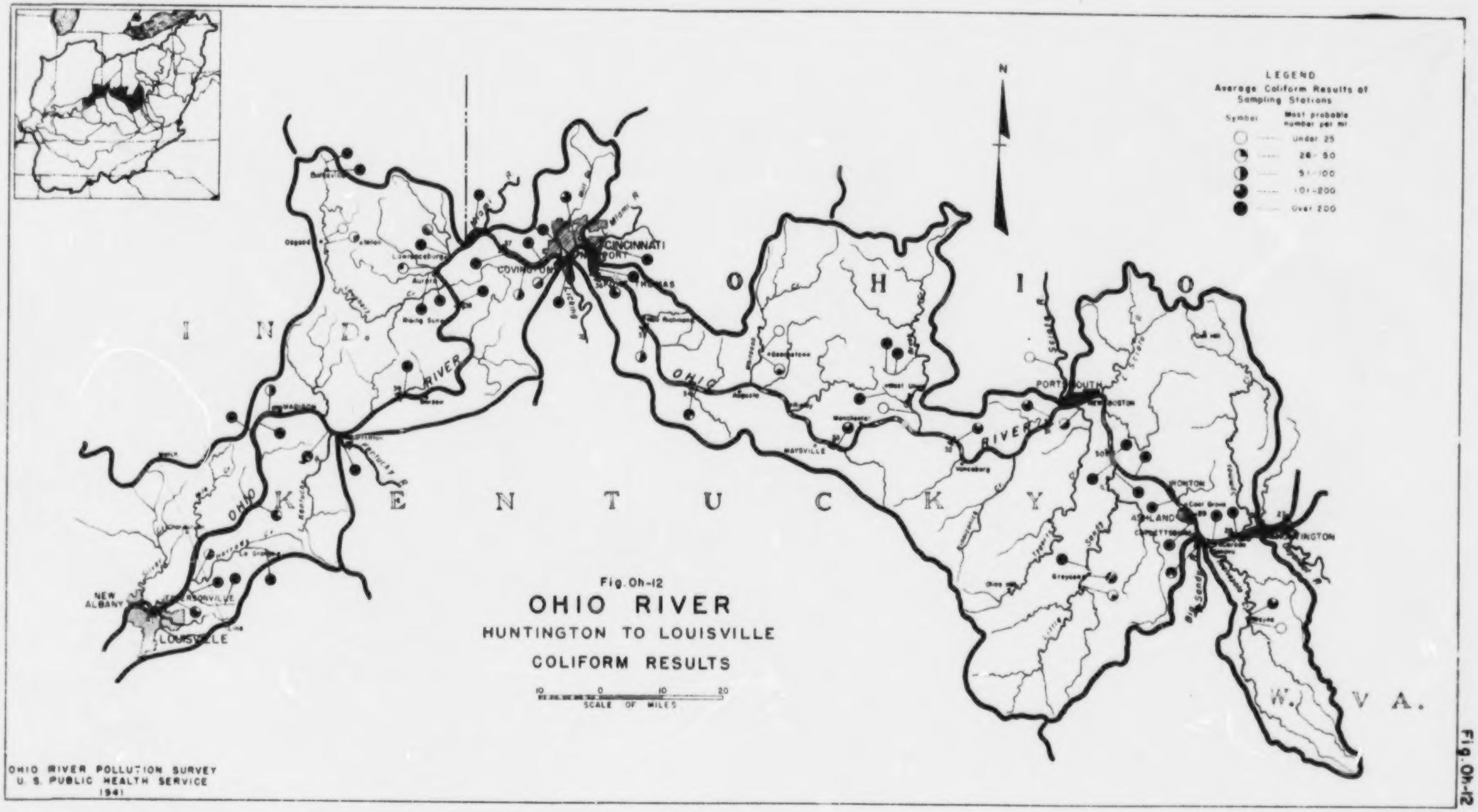

LEGEND
Average Coliform Results of Sampling Stations
Symbol
Most probable number per ml
○ Under 25
◔ 26-50
◑ 51-100
◕ 101-200
● Over 200
N
O H I O
I N D.
K E N T U C K Y
W. V A.
CINCINNATI
COVINGTON
PORTSMOUTH
ASHLAND
HUNTINGTON
IRONTON
MAYSVILLE
NEW ALBANY
LOUISVILLE
OHIO
RIVER
10 0 10 20
SCALE OF MILES

Fig. Oh-12
OHIO RIVER
HUNTINGTON TO LOUISVILLE
COLIFORM RESULTS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig. Oh-13

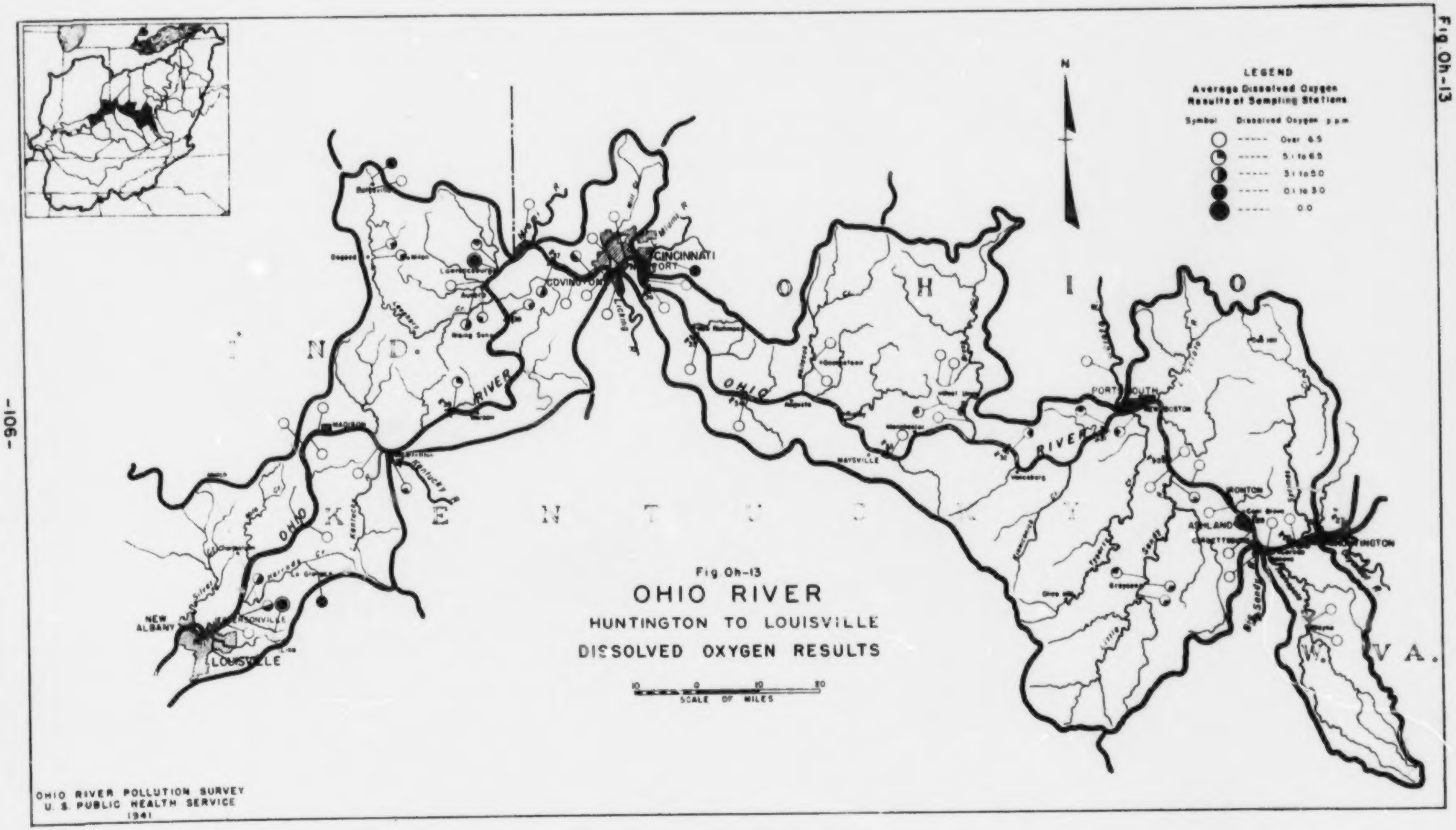

LEGEND
Average Dissolved Oxygen
Results of Sampling Stations
Symbol Dissolved Oxygen p.p.m.
○ ------ Over 6.5
◔ ------ 5.1 to 6.5
◑ ------ 3.1 to 5.0
● ------ 0.1 to 3.0
● ------ 0.0
N
O H I O
I N D.
K E N T U C K Y
W. VA.
CINCINNATI
NEWPORT
COVINGTON
PORTSMOUTH
IRONTON
ASHLAND
HUNTINGTON
MAYSVILLE
MADISON
NEW ALBANY
JEFFERSONVILLE
LOUISVILLE
OHIO RIVER
Licking R.
Kentucky R.
Big Sandy R.
10 0 10 20
SCALE OF MILES

Fig. Oh-13

OHIO RIVER

HUNTINGTON TO LOUISVILLE

DISSOLVED OXYGEN RESULTS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

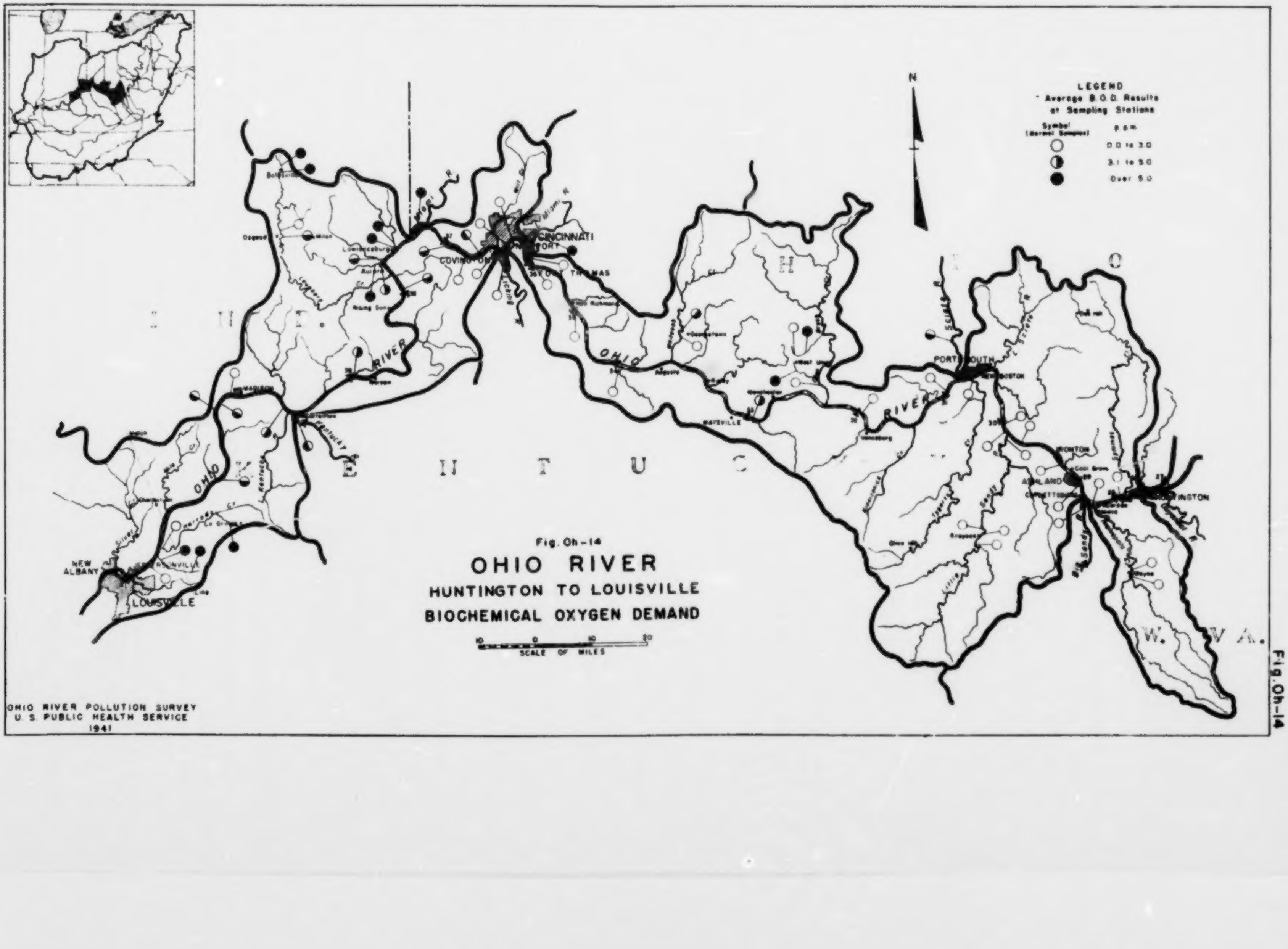

LEGEND
* Average B.O.D. Results at Sampling Stations
Symbol (normal Samples)
p.p.m.
○ 0.0 to 3.0
◐ 3.1 to 5.0
● Over 5.0
N
CINCINNATI
NEWPORT
COVINGTON
FT. THOMAS
Lawrenceburg
Aurora
Rising Sun
MADISON
Carrollton
Kentucky R.
Licking R.
OHIO
RIVER
MAYSVILLE
Augusta
Vanceburg
PORTSMOUTH
NEW BOSTON
Scioto R.
IRONTON
ASHLAND
CATLETTSBURG
HUNTINGTON
Big Sandy R.
NEW ALBANY
LOUISVILLE
I N D.
K E N T U C K Y
O
W. VA.
10 0 10 20
SCALE OF MILES

Fig. Oh-14

OHIO RIVER

HUNTINGTON TO LOUISVILLE

BIOCHEMICAL OXYGEN DEMAND

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

No. of Months Observed	Average Discharge Range Thous.Sec.Ft.	Per cent of time Maximum Average Coliform Counts appeared at:			
		Riverside (475)	Dam 37 (483)	Dam 38 (503)	Dam 39 (532)
2	Under 15	100.0	-	-	-
3	15 - 30	33.3	66.7	-	-
3	31 - 75*	66.7	33.3	-	-
6	Over 75*	16.7	-	67.3	16.7

No. of Months Observed	Average Temperature Range °C.	Per cent of time Maximum Average Coliforms appeared at:			
		Riverside	Dam 37	Dam 38	Dam 39
8	Under 15°C.	25.0	12.5	50.0	12.5
6	15°C.and over	66.7	33.3	-	-

* Pool stage ceases and open channel conditions obtain at flows over approximately 60,000 c.f.s.

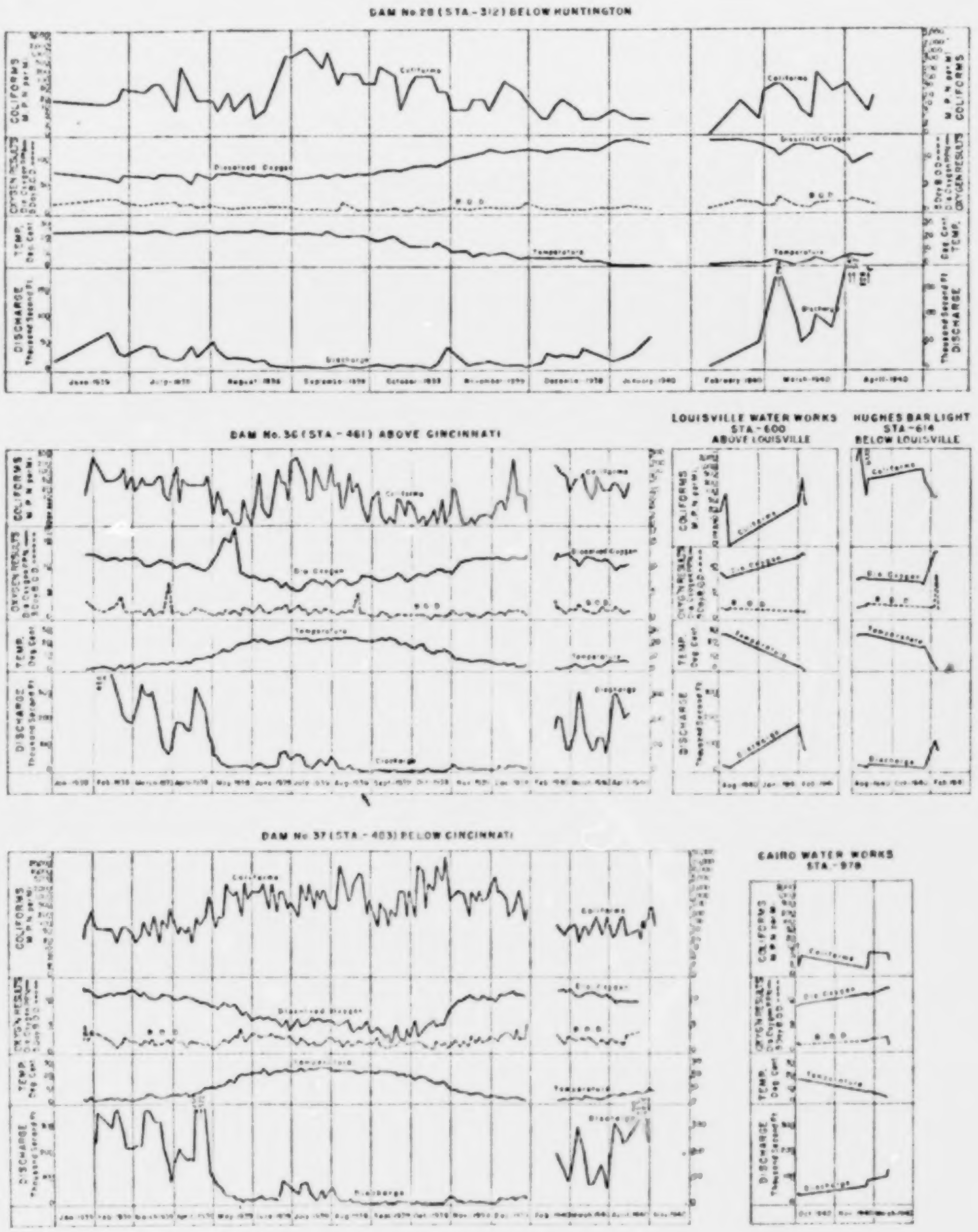
In the section below Dam 39 an increase in coliform concentration is indicated immediately below Madison, especially marked during the July and August study but less marked in October and January. Dissolved oxygen saturation increased from Dam 39 to Louisville in July with a slight depression at Madison and fairly high dissolved oxygen saturations were observed in October and January. Oxygen demand results varied from about 2 to 3.5 p.p.m., being in excess of 3. p.p.m. more frequently in the cooler months. Nearly 60 percent of the samples at the Louisville waterworks intake had coliform counts in excess of 50 per ml.

Louisville to Mouth

The heaviest zones of pollution in the lower river were found immediately below Louisville and in the Evansville-Henderson district with smaller sources of pollution at Owensboro, Paducah and Cairo. Five major tributaries enter the Ohio River in this section, the Salt, Green, Wabash, Cumberland and Tennessee.

At the time of sampling, oxygen conditions throughout the section were good, even below the larger communities. Some

OHIO RIVER LABORATORY RESULTS
AT INDIVIDUAL STATIONS



OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

Fig. Ch-15

105 B

depression in dissolved oxygen was noted in August and October, 1940 below Louisville with recovery at Dam 43, about 25 miles downstream. This depression was not noted in February 1941 despite a sharp increase in oxygen demand below Louisville which was probably due to the rapid rise in the river at this time. (Figure Oh-7, Oh-15 and Table Oh-5). The dissolved oxygen remained near or above saturation throughout the remainder of the section.

Oxygen demands were, for the most part, below 3 p.p.m., even below Louisville, except during the period of observation in January, February and March, 1941 when disturbed flow conditions apparently brought about erratic results with averages approaching 5 p.p.m. The coliform results reached their highest averages in the 10-mile stretch below Louisville in October 1940. Sharp increases also appeared below Owensboro in October, below Evansville in August and October, and below Cairo in all three observational periods. Figure Oh-7 and Table Oh-5 show the relatively cleaner waters existing in the lower reaches of the river. All tributaries entering the section are in good sanitary condition at their mouths.

Marked evidence of self-purification is indicated in the long, relatively unpolluted stretch between Louisville and Evansville, as measured both by oxygen demand and by coliform reductions. In the extreme lower portion of the river little evidence was observed of the heavy pollution loads placed upon the stream between Pittsburgh and points within 200 miles of the mouth of the Ohio, thus showing the ability of the stream to cleanse itself by natural means of the successive loads of untreated wastes discharged to it. Except for the two areas below Louisville and Evansville, this section of the Ohio River was found to be relatively clean at the time of sampling.

Biological Summary - The results of the biological survey of the Ohio River indicated:

(1) The plankton population of the Ohio River was characteristically different from that of the tributaries. The Ohio supports large numbers of diatoms of genera not prominent in the tributaries. Modifying these conditions was the acidity of the upper river which resulted in closteriopsis, a form dominating the acid waters of the Monongahela River, which extended its range downstream in the acid waters to Marietta, Ohio.

(2) The plankton population of the main Ohio River was generally lower than that of the tributaries with the exception of the Green and Cumberland Rivers. Acid conditions in the upper River reduced the volume of plankton considerably as far downstream as Marietta during the period of observation. A tendency toward a gradual increase in plankton was observed downstream from Marietta, with a slight peak below Cincinnati and indications of a peak below Louisville due to the increase in fertility below these cities.

Fig. Oh-16

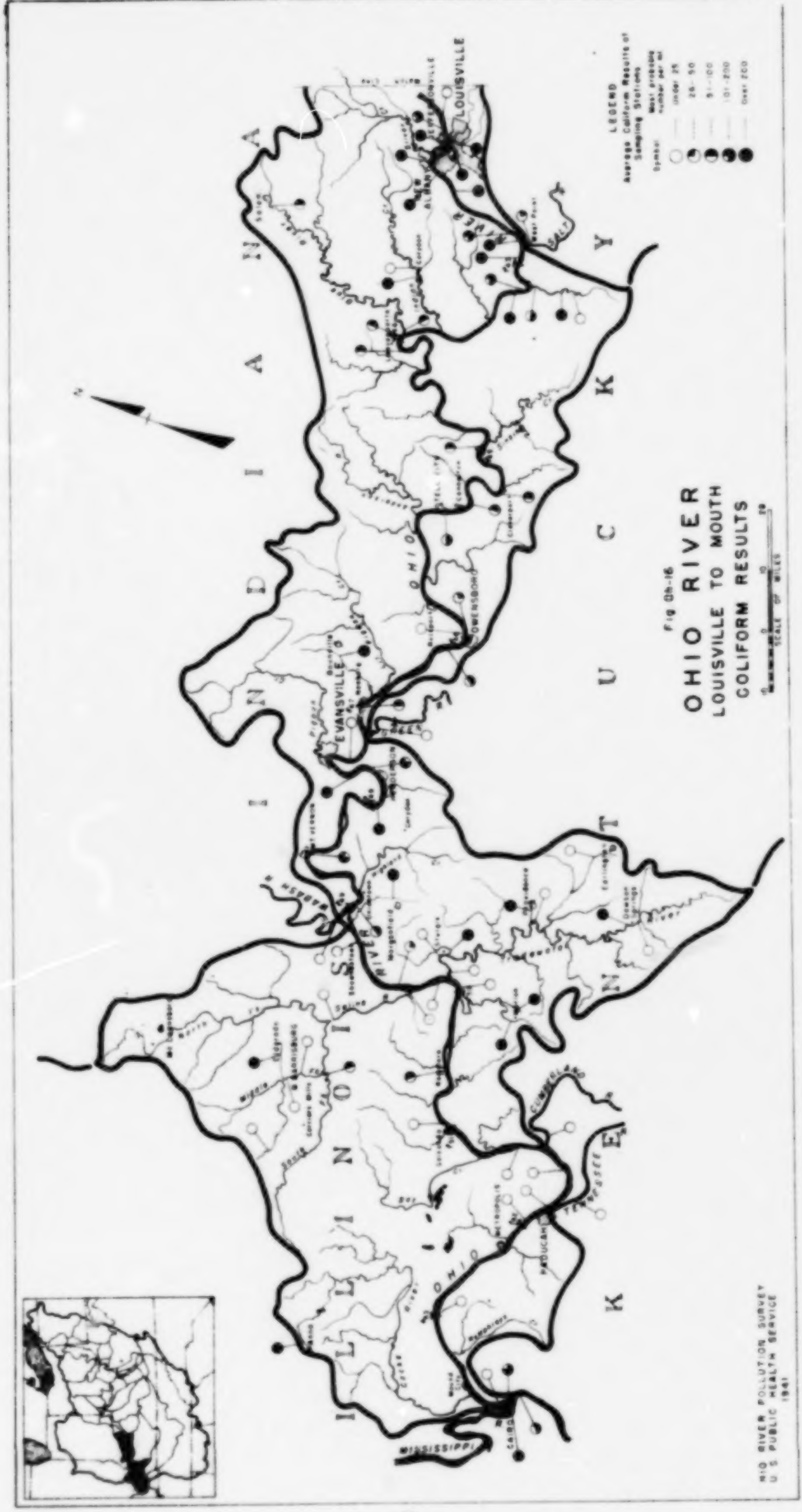
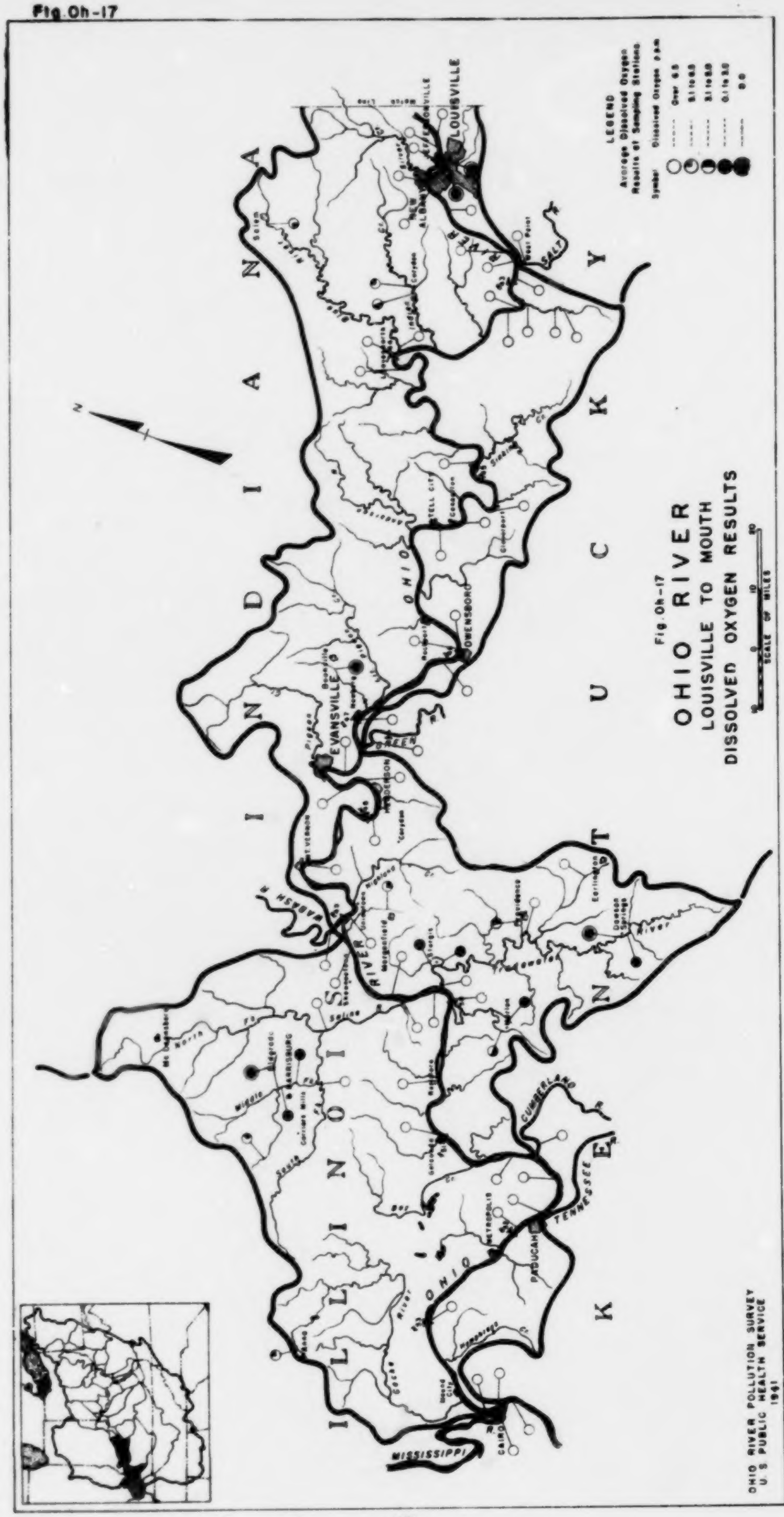

LEGEND
Average Coliform Results of Sampling Stations
Symbol
Most probable number per ml
Under 25
26 - 50
51 - 100
101 - 200
Over 200
SCALE OF MILES
0
10
20
INDIANA
ILLINOIS
KENTUCKY
LOUISVILLE
NEW ALBANY
JEFFERSONVILLE
SALT
OHIO
TELL CITY
OWENSBORO
EVANSVILLE
HENDERSON
RIVER
CUMBERLAND
TENNESSEE
METROPOLIS
PADUCAH
CAIRO
MISSISSIPPI

Fig Oh-16
OHIO RIVER
LOUISVILLE TO MOUTH
COLIFORM RESULTS

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1941

Fig. Oh-17



INDIANA
ILLINOIS
KENTUCKY
N
LEGEND
Average Dissolved Oxygen
Results of Sampling Stations
Symbol
Dissolved Oxygen p.p.m.
○ Over 6.5
◔ 5.1 to 6.5
◑ 3.1 to 5.0
◕ 0.1 to 3.0
● 0.0
SCALE OF MILES
0
10
20
30
LOUISVILLE
JEFFERSONVILLE
NEW ALBANY
SALT
OWENSBORO
TELL CITY
EVANSVILLE
GREEN R.
HENDERSON
MT. VERNON
WABASH R.
OHIO
RIVER
HARRISBURG
CUMBERLAND R.
TENNESSEE R.
PADUCAH
METROPOLIS
MISSISSIPPI R.
CAIRO

Fig. Oh-17

OHIO RIVER
LOUISVILLE TO MOUTH
DISSOLVED OXYGEN RESULTS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Fig.Oh-18

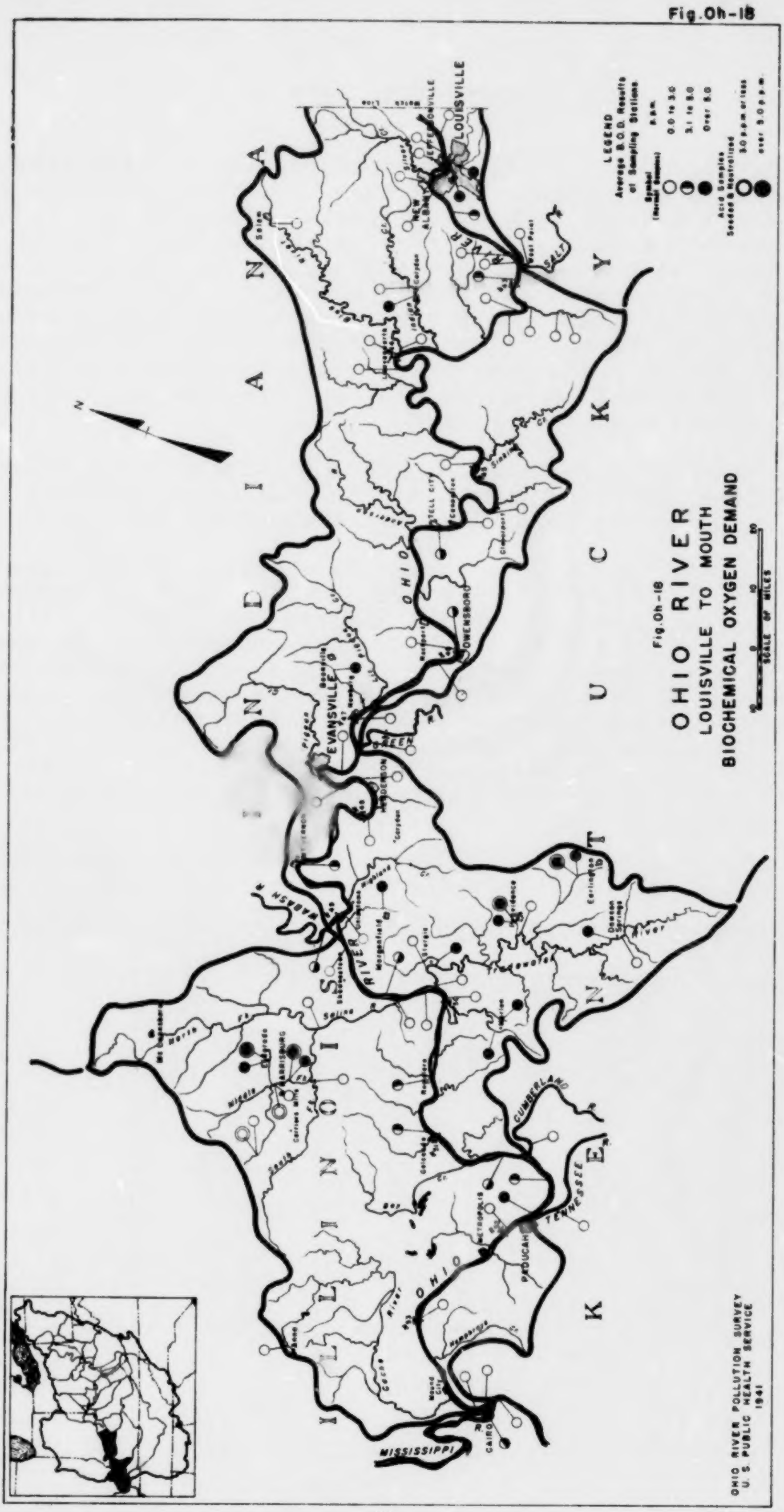


Fig. Oh-18
OHIO RIVER
LOUISVILLE TO MOUTH
BIOCHEMICAL OXYGEN DEMAND
LEGEND
Average B.O.D. Results
of Sampling Stations
Symbol
(Normal Samples)
p.p.m.
○ 0.0 to 3.0
◐ 3.1 to 5.0
● Over 5.0
Acid Samples
Seeded & Neutralized
○ 3.0 p.p.m. or less
● over 3.0 p.p.m.
SCALE OF MILES
0
10
20
I L L I N O I S
I N D I A N A
K E N T U C K Y
LOUISVILLE
JEFFERSONVILLE
NEW ALBANY
SALT
EVANSVILLE
HENDERSON
OWENSBORO
GREEN R.
WABASH R.
RIVER
OHIO
CUMBERLAND R.
TENNESSEE R.
PADUCAH
METROPOLIS
HARRISBURG
CAIRO
MISSISSIPPI
N
OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
1941

Hydrometric Data

Although continuous, long-term records of gage heights are available at many points along the Ohio River, reliable flow records are lacking. This is especially true of low flow data which are of particular interest in this survey. At Pittsburgh since 1923, at Huntington since 1934, and at Louisville since 1928 low flow records are fairly accurate. Prior to those dates the records are less trustworthy. Flows during 1930 were by far the lowest of dependable record at Pittsburgh and Louisville and 1939 was the second dryest year, based on minimum monthly average flows. Table Oh-6 shows the flow at three stations during the dryest summer months of record.

A study of gage heights, precipitation records and tributary stream flow indicates that the 1930 flows were probably the lowest experienced in the Ohio River since about 1860.

Low-flow Regulation- Reservoir sites on tributaries of the Ohio River have been studied by the U. S. Engineer Department in connection with the authorized program for flood control in the Ohio Basin. The possible use of these reservoirs for low-flow regulation has been considered and is discussed in reports on the various tributaries. The reservoirs on the Allegheny and Monongahela Rivers and their tributaries above Pittsburgh would be of particular value to pollution abatement if operated for low-flow control. These reservoirs could aid in control of acid pollution as pointed out in the section of the report on Acid Mine Drainage.

Table Oh-6 Main Ohio River - Monthly Mean Summer Flows for Years in Which Low Summer Flows have Occurred.

Location		Pittsburgh, Pa.	Huntington, W.Va.	Louisville, Ky.
River Miles Above: Mouth of Ohio		981	674	374
Drain.Area Sq. Mi.		19,100	55,200	91,200
Period of Record		1923-40	1934-40	1928-40
Year		1930	1939	1930
June	c.f.s.	10,000	39,800	25,300
July	"	3,300	39,600	8,000
August	"	1,300	20,400	4,900
September	"	1,400	7,840	6,000
Year		1939	1936	1939
June	"	15,500	15,100	68,920
July	"	13,400	16,300	70,440
August	"	6,100	15,600	33,180
September	"	3,040	11,500	8,590
Year		1929	1934	1932
June	"	14,000	-	33,500
July	"	12,000	-	99,800
August	"	4,000	34,900	27,200
September	"	4,000	12,700	8,650

Discussion

From the data presented it is apparent that the most important effect of pollution reaching the Ohio River is the unduly heavy bacterial loadings placed on many of the 30 water purification plants along the stream. Effects of somewhat lesser importance are the taste and odor difficulties at the water plants, the general loss of recreational values, the occasional destruction of fish life and the nuisance conditions due to occasional oxygen depletion below the largest cities, and to scum, floating solids, and discoloration of the stream at these and many smaller places.

Comparison of Results of Various Surveys - No previous surveys of Ohio River tributaries comparable to the present one have been made. No laboratory data therefore are available from which to determine pollution trends for any considerable portion of the watershed outside the main Ohio River.

Investigations of limited portions of the main river were made in 1914-15, and in 1929-30 prior to the present study. Previous surveys covered longer periods of time but the main river sections studied were relatively short and represented only a small percentage of the 981 miles of river. The present survey has been more extensive in its scope, covering the entire watershed, but the analytical data collected at any one particular station have of necessity been limited.

Lack of comparable data is therefore the greatest factor in preventing studies of past and present conditions along the river. Of considerable importance also is the difference in laboratory technique between the first and last survey, which to a considerable extent prevents comparisons between the oxygen demand results, indicative of the organic pollution load on the stream. Complicating the laboratory procedures, both chemical and bacteriological, for examinations of water in the upper Ohio, are the presence and variation in concentration of acid. In many instances comparable sampling points are lacking.

During the summer periods of pool stage with the navigation dams in operation, measurements of stream discharge are less accurate and the pools, acting as sedimentation basins, remove by deposition varying amounts of suspended matter, depending on the amount of flow through and the distribution of velocities in the pools. Many of these dams have been constructed since the earlier surveys and some in existence in 1914-15 have since been replaced, further complicating the comparison of the results of the various surveys.

The most striking change in the river since the original survey, and one about which there can be no doubt, has been the increase in acid concentration in the upper Ohio River. Acid mine drainage, and to a lesser degree spent acid liquors from manufacturing processes, now affect the river as far downstream as the mouth of the Kanawha River (Mile 266*). On numerous occasions the water supply of Pomeroy, Ohio (Mile 248*) has been affected by acid in the river water. Water plants in the acid zone have experienced definite increases, not only in acid concentration but in the duration of the acid periods. During the 1914 survey, acid conditions were occasionally observed as far downstream as Wheeling, W. Va., (Mile 90*). If the increasing acid trend continues without abatement, it is believed the main river as far downstream as the Scioto River (Mile 356*) may become acid occasionally.

The records of raw water coliform examinations at some of the Ohio River water plants constitute the only continuous long-time records of the quality of Ohio River water. Changes in location of intakes and in laboratory methods make comparisons at some of the plants impossible.

Monthly average raw water coliform results at the Cincinnati water plant from 1926 to 1941 are shown in Figure Oh-19. These data are expressed in terms of the "Phelps Index" rather than as "Most Probable Numbers" (M.P.N.) since the early results were available only in this form. These data show that during every year since 1935 the annual average coliform counts have exceeded the safe average for treatment by ordinary filtration and chlorination. Additional treatment and careful operation have made possible the production of drinking water of satisfactory bacterial quality but the water is often unpalatable. A number of other water supplies from the river are much more heavily polluted.

During the 25 years since the first survey of the pollution of the Ohio River the population of the basin, as a whole, has increased by about 22 percent and the population adjacent to the Ohio River by about 24 percent. A larger proportion of the population is served by sewers now than was in 1915, but progress in sewage treatment has been marked. Because the recently completed survey of sewered communities was more complete than that of the earlier survey, the figures shown below are not strictly comparable but they probably represent the changes that have occurred within about five percent.

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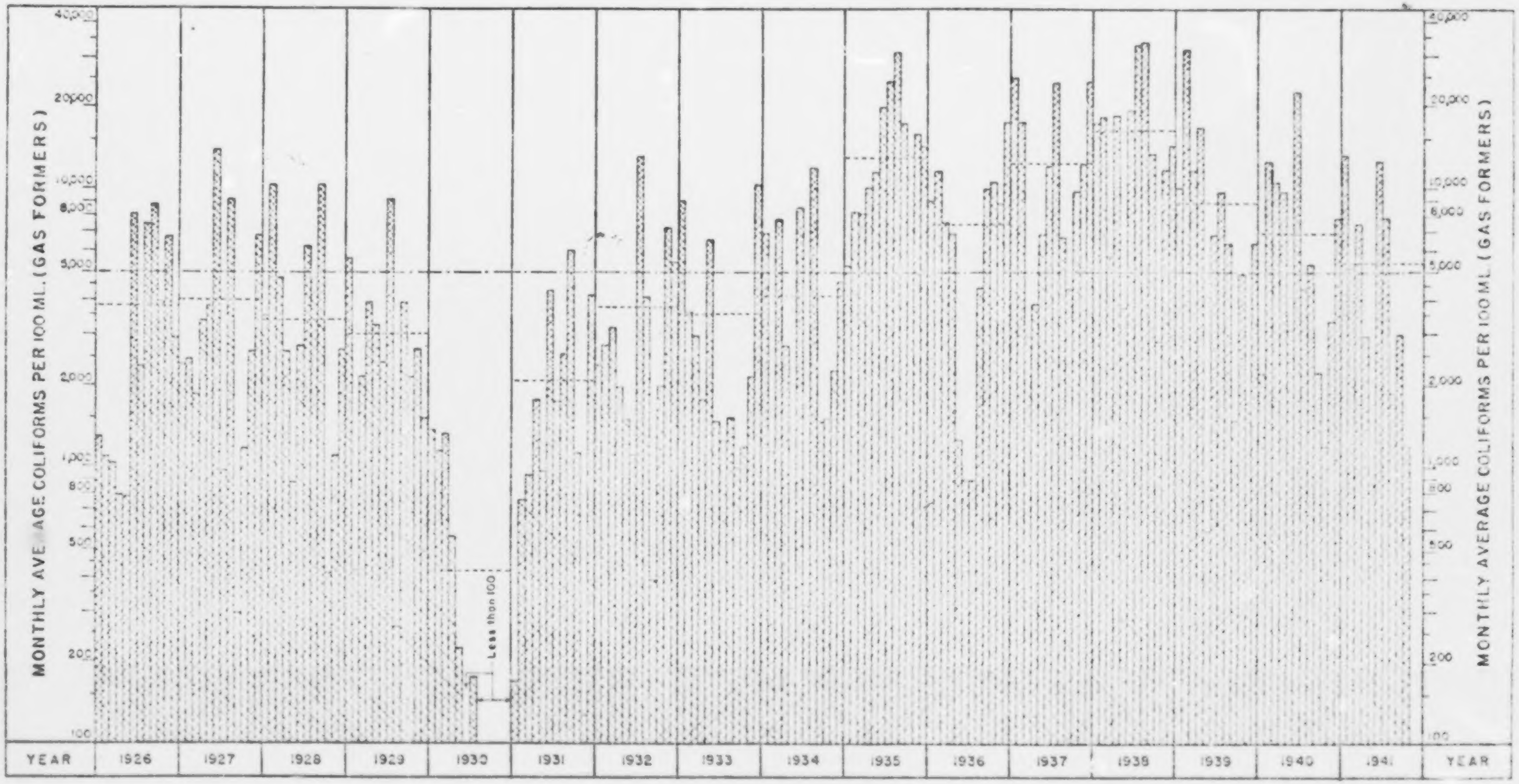
* River miles below Pittsburgh.

Fig. Oh-19

COLIFORM RESULTS-OHIO RIVER AT CINCINNATI WATER WORKS

1926-1941



NOTE:

- - - - - - - - Indicates Average Yearly Coliform Results.

— · — · — Limiting Monthly Average Coliform Number For Satisfactory Treatment by ordinary Filtration Process.

OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1942

	1914-15 Survey	Present Survey	Per Cent Increase
Entire Ohio Basin - Population			
Total	15,381,000	18,824,000	22
Urban	5,694,600	8,222,300	44
Served by sewers	4,106,600	8,561,200	108
To treatment plants	483,900	2,913,000	502
Untreated	3,622,700	5,618,200	55
Ohio River and Minor Tributaries			
Total	3,308,900	4,091,100	24
Urban	2,062,900	2,709,100	31
Served by sewers	1,680,500	2,822,200*	68
To treatment plants	27,700	133,000*	380
Untreated	1,652,800	2,689,200*	63

From these data it can be seen that the amount of waste material of human origin reaching the Ohio River and its tributaries has increased by 20 to 60 percent during the past 25 years. No comparable figures for changes in the industrial waste load are available.

The factor that has probably been most influential in forcusing attention on the pollution problem of the Ohio River Basin is the periodic taste in municipal water supplies. This is caused in part by certain microscopic organisms whose presence cannot be definitely attributed to pollution but which thrive best in water recovering from pollution, and in part by chemical compounds discharged by such industries as by-product coke plants, some chemical manufacturing plants, oil refineries, and wood-preserving plants. Although these industries existed in 1914, all of them have grown rapidly during the past 25 years and, in spite of recovery and treatment measures aimed at reducing or eliminating the discharge of taste-producing wastes, conditions in general are probably worse today than in 1914. No analytical data are available to substantiate this, however. The increasing public consciousness of tastes and the increasing public consciousness of tastes and the increasing public demand for more palatable water add to the seriousness of the problem. Improvement in water treatment processes has done much toward overcoming tastes, but practical considerations demand that further improvements be made at the sources of the trouble.

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* These figures cover an area comparable with that of the 1914-15 survey which differs slightly from similarly named areas considered in this report.

The increase in acidity and in taste troubles in public water supplies have been the most perceptible changes in the quality of the Ohio River during the past 25 years. Increased sewage and organic industrial waste pollution has been less noticeable, due largely to the fact that the flow in the Ohio is sufficient to prevent grossly offensive conditions during a large part of the time.

Ohio River Valley Water Sanitation Compact - One of the major factors hindering the progress of pollution abatement along the Ohio River is the lack of any governmental agency with adequate statutory power to carry on an effective program with respect to the stream. This is due largely to its interstate character. Except for its upper 40 miles which are in Pennsylvania, the river forms state boundaries. West Virginia and Kentucky, a part of the original thirteen states, claimed ownership of the river and as a result the state boundary is at the low water line on the right bank of the river. Thus Ohio, Indiana and Illinois have no jurisdiction over the stream.

Efforts at joint action by the agencies of the various states engaged in pollution abatement work in the Ohio Basin date from 1924 when a conference of state health commissioners was held to consider methods of eliminating or satisfactorily treating phenolic wastes which were causing tastes and odors in public water supplies. In that same year a cooperative agreement was entered into by the various state health departments and through their concerted effort considerable progress was made in controlling phenolic waste. The agreement had no legal status and no progress was made in controlling sewage pollution or that resulting from other types of industrial wastes.

In 1936 the Congress authorized* the negotiation of an interstate compact between the states of the Ohio River Basin. The compact was drafted, approved by the Congress,** and ratified by the state legislatures of Illinois, Indiana, Kentucky, New York, Ohio (whose ratification becomes effective when New York, Pennsylvania and West Virginia enter into the compact) and West Virginia (whose ratification becomes effective when New York, Ohio, Pennsylvania and Virginia enter into the compact). It becomes effective upon ratification by five states and consequently requires either ratification by Pennsylvania or removal of the qualifications placed on their ratifications by Ohio and West Virginia.

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* Public Res.No.104, 74th Congress, approved June 8, 1936.
** Public No. 739, 76th Congress, approved July 11, 1940.

The principal provisions of the compact are:

Article 1. Each signatory state pledges co-operation in controlling and abating pollution and agrees to enact any necessary legislation.

Article 2. Creates "Ohio River Valley Water Sanitation District" comprising all of the Ohio River Basin within the signatory states.

Article 3. Creates "Ohio River Valley Water Sanitation Commission."

Article 4. Commission to consist of three members from each state and three representing the Federal Government.

Article 5. Commission to elect officers, may hire and discharge employees, establish offices, etc. Shall report annually to various state governors on activities.

Article 6. "It is recognized by the signatory states that no single standard for the treatment of sewage or industrial wastes is applicable in all parts of the District due to such variable factors as size, flow, location, character, self-purification, and usage of waters within the District. The guiding principle of this compact shall be that pollution by sewage or industrial wastes originating within a signatory state shall not injuriously affect the various uses of the interstate waters as hereinbefore defined.

"All sewage from municipalities or other political subdivisions, public or private institutions, or corporations, discharged or permitted to flow into these portions of the Ohio River and its tributary waters which form boundaries between, or are contiguous to, two or more signatory states, or which flow from one signatory state into another signatory state, shall be so treated, within a time reasonable for the construction of the necessary works, as to provide for substantially complete removal of settleable solids, and the removal of not less than forty-five percent (45%) of the total suspended solids; provided that, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article 1, in specific instances such higher degree of treatment shall be used as may be determined to be necessary by the Commission after investigation, due notice and hearing.

"All industrial wastes discharged or permitted to flow into the aforesaid waters shall be modified or treated, within a time reasonable for the construction of the necessary works, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article 1, to such degree as may be determined to be necessary by the Commission after investigation, due notice and hearing.

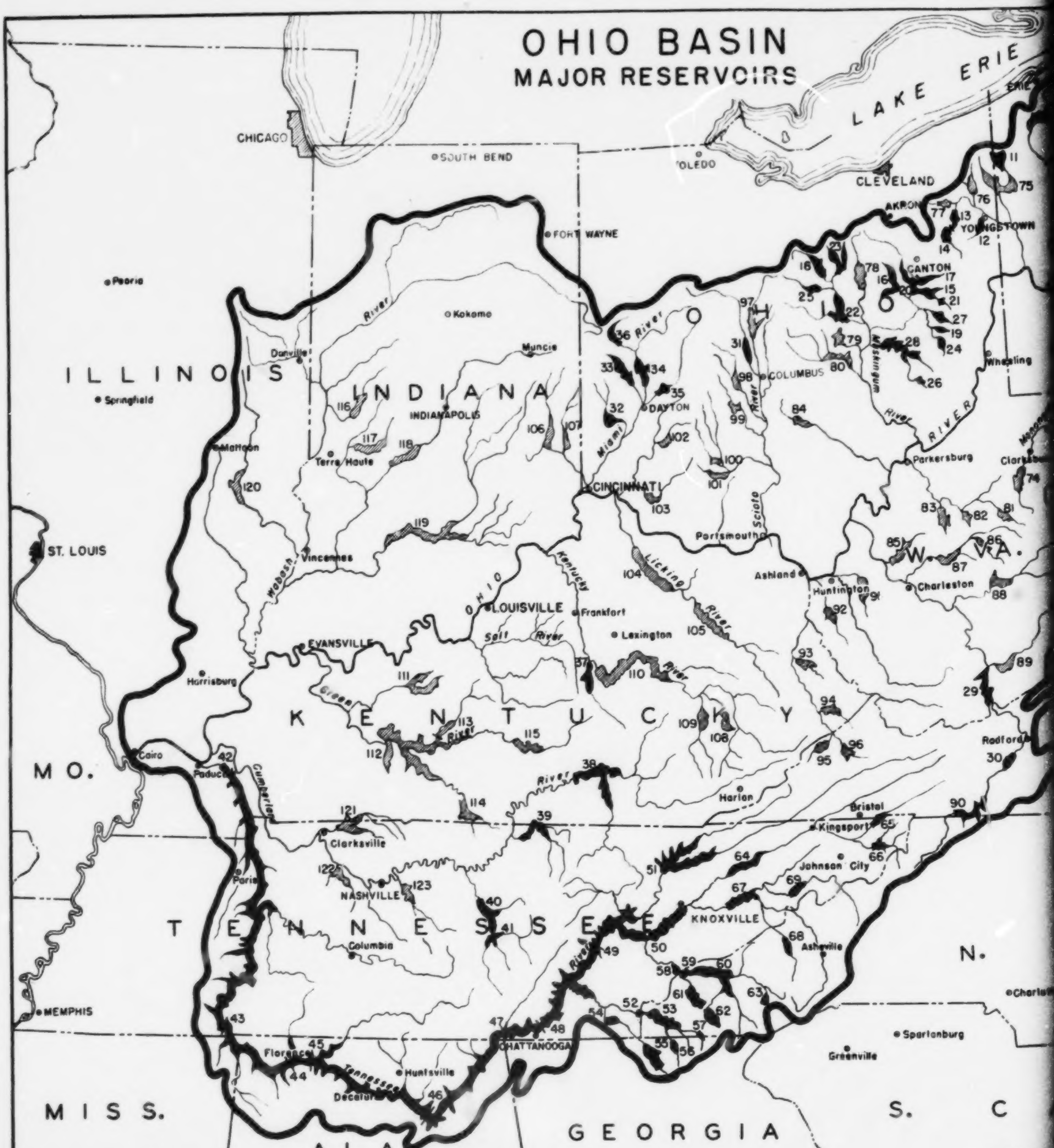
"All sewage or industrial wastes discharged or permitted to flow into tributaries of the aforesaid waters situated wholly within one state shall be treated to that extent, if any, which may be necessary to maintain such waters in a sanitary and satisfactory condition at least equal to the condition of the waters of the interstate stream immediately above the confluence.

"The Commission is hereby authorized to adopt, prescribe and promulgate rules, regulations and standards for administering and enforcing the provisions of this article."

Article 7. Compact does not limit power of states to require higher degrees of treatment.

Article 8. Commission shall conduct a survey of the District and make a comprehensive report; shall draft and recommend legislation to state governors; shall consult with states, municipalities, industries, etc., on pollution problems.

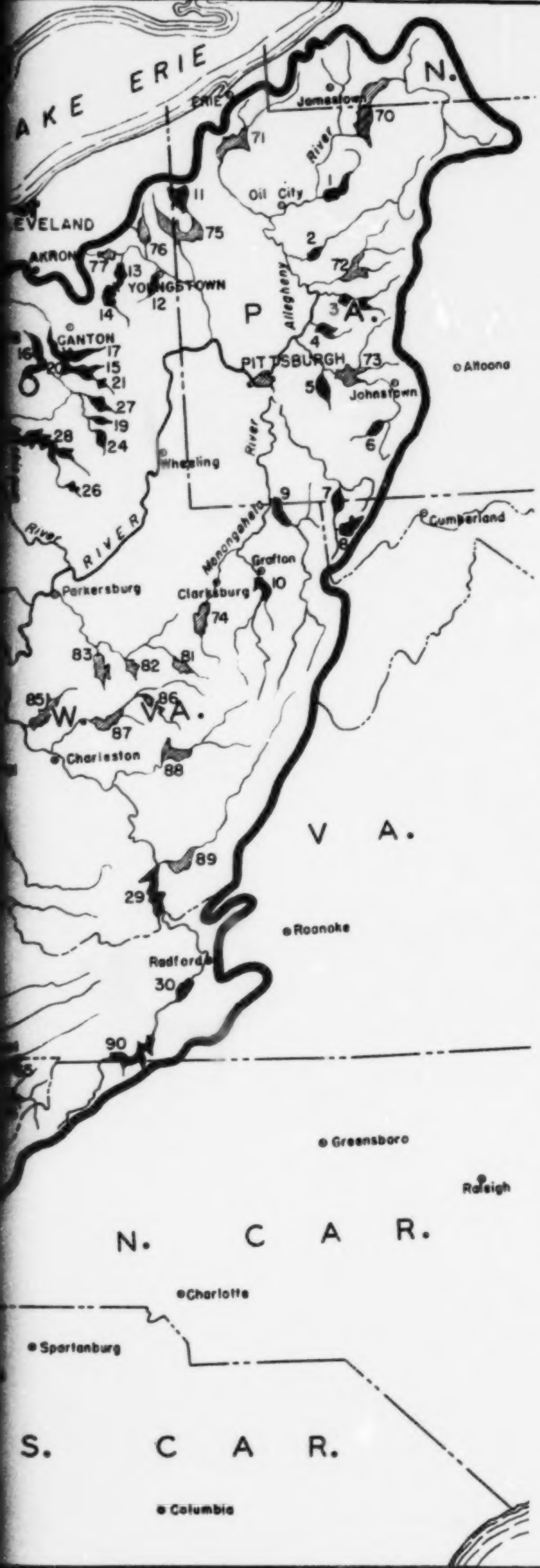
Article 9. "The Commission may from time to time, after investigation and after a hearing, issue an order or orders upon any municipality, corporation, person, or other entity discharging sewage or industrial waste into the Ohio River or any other river, stream or water, any part of which constitutes any part of the boundary line between any two or more of the signatory states, or into any stream any part of which flows from any portion of one signatory state through any portion of another signatory state. Any such order or orders may prescribe the date on or before which such discharge shall be wholly or partially discontinued, modified or treated or otherwise disposed of. The Commission shall give reasonable notice of the time and place of the hearing to the



OHIO BASIN
MAJOR RESERVOIRS

OHIO RIVER POLLUTION SURVEY
U. S. PUBLIC HEALTH SERVICE
MARCH 1942

LAKE ERIE
CHICAGO
SOUTH BEND
TOLEDO
CLEVELAND
AKRON
YOUNGSTOWN
CANTON
FORT WAYNE
Peoria
Kokomo
Muncie
Danville
Springfield
ILLINOIS
INDIANA
INDIANAPOLIS
Terre Haute
Mattoon
DAYTON
COLUMBUS
Wheeling
Parkersburg
Clarksburg
CINCINNATI
Portsmouth
Ashland
Huntington
Charleston
W. VA.
ST. LOUIS
Vincennes
Wabash
LOUISVILLE
Frankfort
Lexington
Salt River
Kentucky
Licking River
EVANSVILLE
Harrisburg
Green River
KENTUCKY
Harlan
Bristol
Kingsport
Johnson City
Radford
MO.
Cairo
Paducah
Cumberland
Clarksville
NASHVILLE
Columbia
TENNESSEE
KNOXVILLE
Asheville
Paris
MEMPHIS
Florence
Huntsville
Decatur
Tennessee
CHATTANOOGA
Spartanburg
Greenville
MISS.
ALA.
Gadsden
GEORGIA
S. C
N.
Charlotte
Columbia
Miami
Scioto
Muskingum
River
OHIO
RIVER
25 0 25 50 75
SCALE OF MILES
1 11 12 13 14 15 16 17 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123


LAKE ERIE
ERIE
N.
Jamestown
70
71
Oil City
River
1
11
EVELAND
75
76
AKRON
77
13
YOUNGSTOWN
12
14
2
72
Allegheny
P
A.
3
4
CANTON
16
17
15
21
20
27
19
24
28
26
PITTSBURGH
73
Altoona
5
Johnstown
6
Wheeling
River
9
7
Monongahela
8
Cumberland
RIVER
River
Grafton
Parkersburg
Clarksburg
10
74
83
82
81
85
86
W. VA.
87
Charleston
88
V A.
89
29
Roanoke
Radford
30
90
Greensboro
Raleigh
N. CAR.
Charlotte
Spartanburg
S. CAR.
Columbia

RESERVOIRS COMPLETED OR UNDER CONSTRUCTION

— LEGEND

No.	Name	Major Purposes	Ownership	Capacity Acre-Feet
1	Tionesta	F	F	125,600
2	Piney	P	P	28,200
3	Mahoning Cr.	F	F	69,500
4	Crooked Cr.	F	F	89,500
5	Loyalhanna	F	F	93,500
6	Quemahoning	I	P	31,800
7	Youghiogheny	FA	F	249,000
8	Deep Cr.	P	P	106,000
9	Lake Lynn	P	P	72,300
10	Tygart	FN	F	278,800
11	Pymatuning	FIA	S	197,000
12	Meander Cr.	M	D	32,400
13	Milton	IA	M	23,000
14	Berlin	FIA	F	71,000
15	Atwood	F	F	49,700
16	Beech City	F	F	71,700
17	Bolivar	F	F	149,600
18	Charles Mill	F	F	88,000
19	Clendenin	F	F	54,000
20	Dover	F	F	203,000
21	Leesville	F	F	37,400
22	Mohawk	F	F	285,000
23	Mohicanville	F	F	102,000
24	Piedmont	F	F	65,000
25	Pleasant Hill	F	F	87,700
26	Senecaville	F	F	88,500
27	Tappan	F	F	61,600
28	Wills Cr.	F	F	196,000
29	Bluestone	FP	F	609,400
30	Claytor	P	P	225,000
31	O'Shaughnessy	M	M	16,400
32	Germantown	F	D	106,000
33	Englewood	F	D	312,000
34	Taylorsville	F	D	186,000
35	Huffman	F	D	167,000
36	Loramie	F	D	70,000
37	Dix	P	P	300,000
38	Wolf Cr.	FP	F	5,782,000
39	Dale Hollow	FP	F	1,639,000
40	Center Hill	FP	F	2,032,000
41	Great Falls	P	F	54,500
42	Kentucky	NFP	F	6,100,000
43	Pickwick Landing	NFP	F	1,091,000
44	Wilson	NP	F	535,000
45	Wheeler	NFP	F	1,150,000
46	Guntersville	NFP	F	1,018,700
47	Hales Bar	NP	F	128,800
48	Chickamauga	NFP	F	705,000
49	Watts Bar	NFP	F	1,132,000
50	Ft. Loudon	NFP	F	365,500
51	Norris	FP	F	2,567,000
52	Apalachia	P	F	50,000
53	Hiwassee No. I	FP	F	438,000
54	Ocoee	P	F	76,600
55	Blue Ridge	P	F	197,500
56	Nottely	P	F	190,000
57	Chatuge	P	F	240,000
58	Calderwood	P	P	34,000
59	Cheoah	P	P	31,000
60	Fontana	FP	F	1,500,000

Continued

No.	Name
61	Santeetlah
62	Nantahala
63	Glenville
64	Cherokee
65	S. Holston
66	Watauga
67	Douglas
68	Waterville
69	Nolichucky

Major Purpo

F – Flood Contro
P – Power
M – Municipal W.
I – Industrial W.
N – Navigation
A – Pollution Ab

PROPOSED FLOOD
MULTIPLE-PURP
IN OHIO VALLEY
PLAN

No.	Name
70	Allegheny
71	French Creek
72	Red Bank Creek
73	Conemaugh
74	West Fork
75	Shenango
76	Mosquito Creek
77	Eagle Creek
78	Millersburg
79	Frazeysburg
80	Dillon
81	Burnsville
82	Steer Cr.
83	West Fork
84	Logan
85	Poca
86	Birch
87	Clendenin
88	Summersville
89	Big Bend
90	Moores Ferry
91	Mud River
92	East Lynn
93	Dewey
94	Fishtrap
95	Clintwood
96	Haysi

OHI
MAJOR

RESERVOIRS COMPLETED OR UNDER CONSTRUCTION

— LEGEND

No.	Name	Major Purposes	Ownership	Capacity Acre-Feet
1	Tionesta	F	F	125,600
2	Piney	P	P	28,200
3	Mahoning Cr.	F	F	69,500
4	Crooked Cr.	F	F	89,500
5	Loyalhanna	F	F	93,500
6	Quemahoning	I	P	31,800
7	Youghiogheny	FA	F	249,000
8	Deep Cr.	P	P	106,000
9	Lake Lynn	P	P	72,300
10	Tygart	FN	F	278,800
11	Pymatuning	FIA	S	197,000
12	Meander Cr.	M	D	32,400
13	Milton	IA	M	23,000
14	Berlin	FIA	F	71,000
15	Atwood	F	F	49,700
16	Beech City	F	F	71,700
17	Bolivar	F	F	149,600
18	Charles Mill	F	F	88,000
19	Clendenin	F	F	54,000
20	Dover	F	F	203,000
21	Leesville	F	F	37,400
22	Mohawk	F	F	285,000
23	Mohiconville	F	F	102,000
24	Piedmont	F	F	65,000
25	Pleasant Hill	F	F	87,700
26	Senecaville	F	F	88,500
27	Tappan	F	F	61,600
28	Wills Cr.	F	F	196,000
29	Bluestone	FP	F	609,400
30	Claytor	P	P	225,000
31	O'Shaughnessy	M	M	16,400
32	Germantown	F	D	106,000
33	Englewood	F	D	312,000
34	Taylorsville	F	D	186,000
35	Huffman	F	D	167,000
36	Loramie	F	D	70,000
37	Dix	P	P	300,000
38	Wolf Cr.	FP	F	5,782,000
39	Dale Hollow	FP	F	1,639,000
40	Center Hill	FP	F	2,032,000
41	Great Falls	P	F	54,500
42	Kentucky	NFP	F	6,100,000
43	Pickwick Landing	NFP	F	1,091,000
44	Wilson	NP	F	535,000
45	Wheeler	NFP	F	1,150,000
46	Guntersville	NFP	F	1,018,700
47	Hales Bar	NP	F	128,800
48	Chickamauga	NFP	F	705,000
49	Watts Bar	NFP	F	1,132,000
50	Ft. Loudon	NFP	F	365,500
51	Norris	FP	F	2,567,000
52	Apalachia	P	F	50,000
53	Hiwassee No. 1	FP	F	438,000
54	Ocoee	P	F	76,600
55	Blue Ridge	P	F	197,500
56	Nottely	P	F	190,000
57	Chatuge	P	F	240,000
58	Calderwood	P	P	34,000
59	Cheoah	P	P	31,000
60	Fontana	FP	F	1,500,000

Continued

No	Name	Major Purposes	Ownership	Capacity Acre-Feet
61	Santeetlah	P	P	156,000
62	Nantahala	P	P	140,000
63	Glenville	P	P	71,000
64	Cherokee	P	F	1,640,000
65	S. Holston	P	F	680,000
66	Watauga	P	F	627,000
67	Douglas	P	F	1,260,000
68	Waterville	P	P	25,000
69	Nolichucky	P	P	

LEGEND

Major Purposes	Ownership
F – Flood Control	F – Federal
P – Power	S – State
M – Municipal W.S.	M – Municipal
I – Industrial W.S.	D – Public District
N – Navigation	P – Private
A – Pollution Abatement	

PROPOSED FLOOD-CONTROL AND MULTIPLE-PURPOSE RESERVOIRS IN OHIO VALLEY FLOOD CONTROL PLAN

— LEGEND

No.	Name	No.	Name
70	Allegheny	97	Delaware
71	French Creek	98	Big Darby
72	Red Bank Creek	99	Deer Creek
73	Conemaugh	100	Paint Creek
74	West Fork	101	Rocky Fork
75	Shenango	102	Caesar Creek
76	Mosquito Creek	103	East Fork
77	Eagle Creek	104	Falmouth
78	Millersburg	105	Cave Run
79	Frazeysburg	106	Metamora
80	Dillon	107	Brookville
81	Burnsville	108	Buckhorn
82	Steer Cr.	109	Booneville
83	West Fork	110	Jessamine Creek
84	Logan	111	Rough River
85	Poca	112	Mining City
86	Birch	113	Nolin River
87	Clendenin	114	No. 2 Barren
88	Summersville	115	No. 2 Green
89	Big Bend	116	Mansfield
90	Moores Ferry	117	Cagles Mill
91	Mud River	118	Spencer
92	East Lynn	119	Shoals
93	Dewey	120	Wolf Creek
94	Fishtrap	121	Rossview
95	Clintwood	122	Three Islands
96	Haysi	123	Stewarts Ferry

FIG.-8

OHIO BASIN
MAJOR RESERVOIRS

20. A

municipality, corporation or other entity against which such order is proposed. No such order shall go into effect unless and until it receives the assent of at least a majority of the commissioners from each of not less than a majority of the signatory states; and no such order upon a municipality, corporation, person or entity in any state shall go into effect unless and until it receives the assent of not less than a majority of the commissioners from such state.

"It shall be the duty of the municipality, corporation, person or other entity to comply with any such order issued against it or him by the Commission, and any court of general jurisdiction or any United States district court in any of the signatory states shall have the jurisdiction, by mandamus, injunction, specific performance or other form of remedy, to enforce any such order against any municipality, corporation or other entity domiciled or located within such state or whose discharge of the waste takes place within or adjoining such state, or against any employee, department or subdivision of such municipality, corporation, person, or other entity; provided, however, such court may review the order and affirm, reverse or modify the same upon any of the grounds customarily applicable in proceedings for court review of administrative decisions. The Commission or, at its request, the Attorney General or other law-enforcing official, shall have power to institute in such court any action for the enforcement of such order."

Article 10. States agree to appropriate their proportion of Commission budget prorated one-half in proportion to population and one-half in proportion to land area within the District.

Article 11. Compact to become effective when ratified by legislatures of majority of states and approved by Congress.

(Signed by compact commissioners for Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Tennessee and West Virginia).

Desirable Degree of Treatment - General application of the compact minimum requirement of substantially complete removal of all settleable solids and removal of at least 45 percent of the suspended solids from all sewage and industrial wastes discharged directly to the Ohio River should be ample to prevent serious oxygen depletion at any place on the Ohio River except Cincinnati under present conditions of waste loads and stream flow. Even in the Cincinnati area conditions would be satisfactory except during periods of extremely low flow. A marked reduction in the acidity of the Ohio River at Pittsburgh would greatly increase the effects of organic pollution and necessitate a higher degree of treatment unless the stream flow during the warm weather months was increased appreciably. At these two places designs for the larger plants should include provisions for more than primary treatment, probably by the addition of coagulants. At all of the larger municipalities and at any of the smaller ones whose sewage would appreciably affect downstream water intakes, continuous chlorination of the treatment plant effluents should be provided for the reduction of bacterial pollution. At places where wastes are being discharged to tributary streams near their junction with the Ohic River, more complete treatment may be necessary to correct local conditions unless the outfalls are extended to the Ohio River.

Low-flow control by means of flood control and multiple-purpose reservoirs in the area above Pittsburgh and Cincinnati might eliminate the need for more than primary treatment of sewage and equivalent treatment of organic industrial wastes at these places. The flow required at Pittsburgh to accomplish this (assuming an effective acid-control program) has been estimated at 8,000 c.f.s. during the warm summer months (25°C. or 77°F. average monthly air temperature) and progressively lesser flows as temperatures decrease. The savings in costs resulting from the use of primary treatment rather than the higher degree of treatment using chemical coagulants is estimated at $300,000 per year at Pittsburgh and an additional $300,000 per year at Cincinnati.

Studies by the U. S. Engineer Department indicate that such flows could be maintained except during such an extremely dry year as 1930 by using existing reservoirs and additional ones above Pittsburgh authorized by the Congress for low-flow control in conjunction with their major purpose of flood control. At Cincinnati, a considerably smaller increase in flow would ensure satisfactory conditions with only primary treatment. Existing reservoirs together with those above Pittsburgh could provide this increased flow.

The bulk of the organic industrial wastes should be treated at municipal plants. In general, removal of settleable solids as required by Article 6 of the Compact should assure adequate industrial waste treatment except at oil refineries, by-product coke plants, and a few other plants where particular attention should be given to those components likely to cause tastes and odors in public water supplies. At plants such as steel mills, acid wastes should be neutralized during periods when their contribution to the acid load on the stream is significant. However, as mine drainage contributes by far the greater acid load, acid mine control by sealing should be well advanced before even part-time neutralization of pickle liquor is justified.

The larger cities along the Ohio River are aware of the necessity of sewage treatment and many of them have made studies to determine how they can most economically collect and treat their wastes. Consulting engineers have recently prepared preliminary plans and estimates for Cincinnati and Louisville. Pittsburgh, Evansville, Wheeling and Huntington had previously studied their sewerage problems.

Pittsburgh - The problem of waste treatment in the Pittsburgh District is highly complicated and cannot be effectively solved by the city alone. Some kind of Authority or Sanitary District comprising the greater part of Allegheny County is almost essential to an economical and thorough pollution abatement program in this area. The county contains 125 cities, boroughs and townships, many of which necessarily use joint sewers. The intensive development of the narrow stream valleys limits the number of available sites for sewage treatment plants. The report of the General Committee on Sewage of the Municipalities of Allegheny County, prepared in 1939, outlines a plan for 19 treatment plants on the lower Allegheny and Monongahela Rivers, the Ohio River and two smaller streams, Turtle Creek and Chartiers Creek. Much more detailed investigation of alternate plans is necessary before any final decision can be made as to the best plan. The largest plant in any case will almost certainly be at a site on Brunots Island where most or all of the sewage from the city of Pittsburgh, as well as from a number of adjoining boroughs and townships, would be treated. Interceptor costs will be high since most construction will be in rock and a considerable part of it will be in tunnel. The estimated cost of interceptors and 19 primary treatment plants in the Committee report is $35,900,000. These would serve most of Allegheny County. Costs as summarized in Table Oh-1 include only those plants on the Ohio River in the Pittsburgh area. The costs of other plants in the metropolitan area are included in summaries of costs in the Allegheny and Monongahela Basins.

Cincinnati - Comprehensive studies of the pollution problem of Cincinnati and its suburbs in Ohio have been made and preliminary plans and estimates have been prepared. Cincinnati has made more progress toward solution of its pollution problem than any other large Ohio River city. Plans call for the ultimate construction of four plants which would treat the wastes of the city and 17 incorporated suburbs as well as a large unincorporated area in Hamilton County. The first plant to be constructed would treat the wastes now entering the Little Miami near its mouth and the Ohio in the upper part of the city. These wastes may affect the water supplies of Cincinnati, Covington and Newport which are taken from the Ohio within a mile upstream from the mouth of the Little Miami. Interceptors for this plant are almost complete. The proposed plant will have a capacity of about 25 m.g.d. and will provide primary treatment and chlorination with provisions for later additions to increase its capacity and to provide more complete treatment.

The largest plant of the four would be located in Mill Creek Valley a short distance from the Ohio River. Its capacity would be about 108 m.g.d. It would treat most of the sewage from Cincinnati and its suburbs and, in addition, large amounts of industrial wastes which make the combined wastes about twice as strong as normal municipal sewage. The plant as planned would provide primary treatment and chlorination with provisions for increases in capacity and in degree of treatment.

The other two plants would be much smaller with a total capacity of about 5 m.g.d. They would serve the lower end of the city and adjoining areas in the county. They would provide the same degree of treatment as the larger plants and their construction would be deferred until the larger plants were completed.

The total capital cost of the entire program is estimated at about $19,000,000.

Little progress has been made toward pollution abatement in the Kentucky communities across the river from Cincinnati. A number of the smaller communities which drain to small wet-weather streams have installed treatment plants but the bulk of wastes still enters the Ohio and Licking Rivers untreated. Co-operative effort seems necessary to any economical program of waste treatment but numerous attempts to form special districts for such work have failed.

Louisville - The recently completed consulting engineers' report on sewage treatment for Louisville proposes a single primary treatment plant to serve the city and some of its suburbs. A large industrial waste load would be treated with the domestic sewage. The plant would have a capacity of about 73 m.g.d. The estimated capital cost for interceptors and treatment is about $6,000,000. The report suggests operation only during low-flow periods. No provision is made for chlorination of the effluent. Because of the short sedimentation period provided (one hour at average design flow) and part-time operation, such a plant would not meet the minimum requirements in Article 6 of the Compact, nor would it provide adequate protection to the New Albany, Ind., water supply. If provisions for chlorination were added and the plant operated continuously it should effectively reduce bacterial pollution below Louisville.

These three large metropolitan areas are the key ones in a program for abatement of pollution in the Ohio River. Although the need for sewage treatment is equally acute at many other communities along the upper Ohio, at Huntington, Ashland and other places where bacterial pollution is affecting downstream public water supplies, it is proper for the larger places to take the lead.

Cost - The cost of a suggested program providing for primary treatment of all wastes entering the Ohio is summarized in Table Oh-1. This suggested program is based on the assumption that low-flow control will make more complete treatment at Pittsburgh and Cincinnati unnecessary. An estimate of the comparative cost of a program for complete treatment of all wastes is included in Table Oh-1.

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Ohio River Emsworth Dam	0	6	Oct.	11	5,460	16.3	4.0	1.1 1.6*	12	5.6	8	7	
" "	"	"	Nov.	9	23,660	9.0	10.3	2.0 1.8*	106	6.2	16	15	
" "	"	"	Dec.	11	51,350	4.4	14.7	1.8	208	6.7	37	13	
" "	"	"	Mar. '41	7	47,750	2.5	13.9	2.2	40	6.1	26	10	
Dashields Lock & Dam	0	13.5	Oct.	11	5,710	16.0	7.8	1.1 1.4*	10	6.6	7	8	
" "	"	"	Nov.	9	23,270	8.3	11.0	2.2 1.6*	93	6.3	18	13	
" "	"	"	Dec.	11	51,070	3.8	13.8	2.0	105	6.6	41	11	
" "	"	"	Mar. '41	7	47,140	2.3	12.9	1.9	38	6.0	25	7	
Beaver River - Mouth	0	25.4	Oct.	11	633	15.2	8.3	2.6	802	6.2	13	33	
" "	(1.4 mi.abv. mo.Beav.R.)		Nov.	8	1,797	8.6	11.0	1.8	141	6.5	25	40	
" "	"	"	Dec.	11	6,228	4.8	12.5	2.7	380	6.7	54	30	
Montgomery Dam	0	31.7	Oct.	11	6,100	16.0	8.3	0.9 1.1*	20	5.6	7	8	
" "	"	"	Nov.	9	24,990	8.8	11.0	1.6	58	6.2	16	15	
" "	"	"	Dec.	9	60,180	3.1	13.8	2.0	102	6.5	39	15	
" "	"	"	Mar. '41	7	53,510	2.4	13.3	2.0	43	6.0	32	9	
Lock & Dam No. 7	0	36.5	Oct.	11	6,110	16.0	10.0	1.0 1.1*	27	5.7	6	9	
" "	"	"	Nov.	9	24,330	8.8	12.2	1.5 1.4*	47	6.3	19	14	
" "	"		Dec.	10	61,900	3.3	14.1	2.1	103	6.5	50	12	
Lock & Dam No. 8	0	46.4	Oct.	12	6,530	15.8	9.8	0.9 1.0*	47	5.6	4	7	
" "	"	"	Nov.	9	24,580	8.8	11.8	1.6 1.2*	43	6.2	21	14	
" "	"	"	Dec.	9	64,610	3.8	13.8	2.2 1.7*	99	6.4	59	12	
" "	"	"	Mar. '41	6	53,320	2.7	13.7	2.4	68	6.0	31	9	
Lock & Dam No. 9	0	56.1	Oct.	12	6,510	15.3	9.7	1.1 1.1*	31	5.5	3	9	
" "	"	"	Nov.	9	24,430	8.8	11.6	1.7 1.4*¢	35	6.2	17	14	
" "	"	"	Dec.	10	64,650	3.7	13.7	2.3	98	6.4	58	13	
Lock & Dam No. 10	0	66	Oct.	12	6,500	16.3	9.4	1.2 1.5*	30	5.4	4	9	
" "	"	"	Nov.	10	23,160	9.1	11.5	1.8 1.6*¢	25	6.2	14	14	
" "	"	"	Dec.	12	59,430	4.5	13.5	1.9	97	6.4	47	12	
" "	"	"	Mar. '41	6	54,080	2.2	13.5	2.1	30	6.1	28	10	
Lock & Dam No. 11	0	77	Oct.	12	6,480	16.3	8.3	1.8 2.8*	61	5.3	5	5	
" "	"	"	Nov.	10	22,920	9.3	11.4	1.7 2.0*¢	26	6.2	16	13	
" "	"	"	Dec.	12	60,160	4.3	13.5	2.2	76	6.4	52	12	
" "	"	"	Mar. '41	6	54,480	2.5	13.5	1.8	22	6.1	28	9	
Lock & Dam No. 12	0	87.5	Oct.	12	6,540	15.7	8.6	1.3 1.6*	10	5.3	6	5	
" "	"	"	Nov.	10	22,680	9.5	11.3	1.6 2.0*¢	22	6.3	16	12	
" "	"	"	Dec.	12	60,910	4.7	13.1	2.1	94	6.4	47	12	
Lock & Dam No. 13	0	96	Oct.	12	6,490	15.6	8.9	1.5 2.1*	43	5.3	6	6	
" "	"	"	Nov.	10	22,490	8.9	11.2	1.5 2.0*¢	59	6.3	17	14	
" "	"	"	Dec.	12	61,520	4.8	13.0	2.2	207	6.4	56	15	
" "	"	"	Mar. '41	6	55,260	2.2	13.2	2.7	18	6.2	28	13	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage from Pittsburgh	Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 14	0 114	May	12	39,050	15.9	9.7	1.1	11	5.3	20	8	
" "	" "	June	10	41,510	22.0	8.2	1.2	435	6.8	62	16	
" "	" "	July	10	19,630	24.4	8.0	0.8	33	6.6	20	15	
" "	" "	Aug.	11	10,450	25.1	7.4	0.9 0.8*	15	4.9	13	13	
" "	" "	Sept.	5	9,740	21.7	8.6	0.8 0.9*	**	4.6	7	3	
" "	" "	Jan. '41	6	51,780	2.4	13.4	2.0	33	6.4	39	15	
" "	" "	Feb. "	2	30,120	2.2	13.2	1.4	34	6.5			
" "	" "	Mar. "	9	55,860	3.2	13.4	2.0	16	6.5	39	12	
Lock & Dam No. 15	0 129	May	12	40,400	15.5	9.7	1.0	7	4.9	32	8	
" "	" "	June	10	43,470	22.2	8.3	1.1	81	6.8	43	16	
" "	" "	July	10	20,210	24.7	8.3	0.9	44	6.7	49	18	
" "	" "	Aug.	11	11,000	25.1	7.7	1.0 0.8*	93	5.4	39	13	
" "	" "	Sept.	5	9,700	21.8	8.6	0.8 0.8*	**	4.7	7	5	
" "	" "	Jan. '41	6	55,000	2.3	13.8	1.8	17	6.4	39	13	
" "	" "	Feb. "	2	28,950	2.0	13.2	1.3	16	6.6	26	14	
" "	" "	Mar.	9	57,960	2.9	13.6	1.8	21	6.5	44	11	
Lock & Dam No. 16	0 146.5	May	12	41,930	16.6	9.7	1.0	7	5.3	32	7	
" "	" "	June	10	45,060	22.2	8.2	1.0	57	6.8	63	16	
" "	" "	July	10	20,880	24.2	8.4	1.0	28	6.7	35	18	
" "	" "	Aug.	11	11,640	25.2	7.7	1.1 1.0*	23	5.6	26	14	
" "	" "	Sept.	5	9,660	21.9	8.8	0.9 0.9*	4	4.8	6	4	
" "	" "	Jan. '41	6	58,520	2.5	13.8	1.9	18	6.4	37	12	
" "	" "	Feb. "	2	27,600	2.1	13.6	1.2	20	6.6	22	14	
" "	" "	Mar. "	9	60,070	3.3	13.6	1.7	11	6.4	43	11	
Lock & Dam No. 17	0 167.5	May	11	42,240	16.0	9.6	1.0	4	5.2	39	7	
" "	" "	June	10	45,880	22.2	8.1	1.6	122	6.6	135	16	
" "	" "	July	9	21,890	[illegible]	8.3	1.4	75	7.0	63	22	
" "	" "	Aug.	11	[illegible]	26.4	7.6	1.2 0.9*	26	6.2	44	12	
" "	" "	Sept.	5	[illegible]	22.4	8.8	1.0 0.9*	3	5.1	8	6	
" "	" "	Jan. '41	7	[illegible]	[illegible]	13.8	2.0	13	6.3	33	12	
" "	" "	Feb. "	2	29,440	1.5	13.6	1.3	8	6.5	19	14	
" "	" "	Mar. "	9	61,480	2.2	13.4	1.8	15	6.4	46	10	
Muskingum River Mouth - Dam No. 1	0 172.2	May	11	9,780	16.0	9.7	1.8	14	7.3	66	85	
" "	(0.2 mi abv. mo.Musk.R.)	June	10	11,962	22.2	8.6	1.6	156	7.5	240	80	
" "	" "	July	9	5,680	25.5	8.2	1.9	28	7.6	56	100	
" "	" "	Aug.	11	2,050	26.4	7.5	2.8	13	7.6	59	102	
" "	" "	Sept.	5	3,360	21.5	8.3	1.3	12	6.7	46	80	
" "	" "	Jan. '41	7	8,620	1.6	14.1	1.4	107	7.4	36	84	
" "	" "	Feb. "	2	10,510	1.2	13.9	1.1	122	7.5	38	76	
" "	" "	Mar. "	8	7,996	2.3	13.6	1.3	49	7.6	47	84	
Argand Landing-Below Marietta & Muskingum R.	0 173.5	May	10	43,610	16.1	9.9	1.1	14	6.6	51	22	
" "	" "	June	10	64,300	22.1	8.3	1.5	112	7.2	137	39	
" "	" "	July	10	31,440	25.4	8.4	1.4	44	7.2	45	49	
" "	" "	Aug.	10	15,000	26.6	7.7	1.4	123	7.1	45	41	
" "	" "	Sept.	6	16,230	22.3	8.7	1.1	24	6.5	23	26	
" "	" "	Jan. '41	6	63,400	1.6	13.8	1.8	34	6.8	58	38	
" "	" "	Feb. "	3	42,800	1.6	13.8	1.3	27	7.1	30	44	
" "	" "	Mar. "	8	65,400	2.5	13.5	1.6	20	6.8	51	24	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C.	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 18	0 180	May	9	41,530	16.4	9.7	1.1	7	6.6	45	22	
" "	" "	June	10	64,300	22.0	8.2	1.5	76	7.1	137	42	
" "	" "	July	10	31,440	25.3	8.3	1.6	30	7.2	45	49	
" "	" "	Aug.	11	15,000	26.3	7.7	1.6	78	7.1	54	41	
" "	" "	Sept.	6	16,230	22.2	8.6	1.3	32	6.5	19	32	
" "	" "	Jan. '41	6	63,400	1.6	13.9	1.5	23	6.8	41	37	
" "	" "	Feb. '41	3	42,800	1.6	13.8	1.3	31	7.0	28	42	
" "	" "	Mar. "	8	65,400	2.4	13.4	1.7	20	6.9	48	34	
Congress Landing-Above Parkersburg, W. Va. and Little Kanawha R.	0 183	May	9	41,530	16.1	9.7	1.1	8	6.6	46	21	
" "	" "	June	10	64,300	21.8	8.2	1.4	79	7.0	122	33	
" "	" "	July	10	31,440	25.0	8.3	1.4	58	7.1	42	37	
" "	" "	Aug.	11	15,000	26.0	7.6	1.5	66	7.0	47	32	
" "	" "	Sept.	2	18,810	23.5	8.2	2.8	41	6.6	34	33	
" "	" "	Jan. '41	6	63,400	1.5	13.8	1.5	14	6.7	42	26	
" "	" "	Feb. "	3	42,800	1.5	13.8	1.2	23	6.9	27	30	
" "	" "	Mar. "	8	65,400	2.4	13.4	1.7	28	6.7	49	20	
L.Kanawha River-0.1 B. & O. R.R. Bridge	0 184.6	May	9	930	16.7	7.8	2.9	1,750	6.7	25	24	
" "	(0.1 mi. abv. mo. L.Kan.R.)	June	10	4,846	21.3	7.6	1.7	1,280	7.1	289	25	
" "	" "	July	10	1,988	25.0	5.6	2.2	1,040	7.0	61	30	
" "	" "	Aug.	11	6,711	25.7	2.8	2.7	2,720	7.0	105	26	
" "	" "	Jan. '41	6	4,918	2.2	12.4	2.2	185	6.9	98	22	
" "	" "	Feb. "	3	1,293	1.8	13.3	2.1	23	6.8	25	17	
" "	" "	Mar. "	8	4,714	2.6	13.0	2.3	57	6.9	109	19	
Rapps Run Light	0 185	May	9	42,460	16.0	9.6	1.2	23	6.6	39	19	
" "	" "	June	10	66,140	21.9	8.1	1.7	103	6.9	120	33	
" "	" "	July	10	33,430	24.9	8.1	1.6	70	7.1	50	37	
" "	" "	Aug.	11	15,680	26.0	7.5	2.2	210	7.0	49	34	
" "	" "	Sept.	2	15,200	23.5	8.2	2.2	53	6.7	38	33	
" "	" "	Jan. '41	6	68,320	1.5	13.8	1.8	45	6.7	44	22	
" "	" "	Feb. "	3	44,090	1.8	13.8	1.4	33	6.8	30	31	
" "	" "	Mar. "	8	70,080	2.3	13.4	1.9	29	6.7	48	22	
Lock & Dam No. 19	0 192	May	10	42,400	16.8	9.7	1.4	59	6.7	41	22	
" "	" "	June	10	70,190	22.8	8.0	1.8	119	7.1	135	32	
" "	" "	July	12	33,840	25.1	8.2	2.0	72	7.3	65	38	
" "	" "	Aug.	11	16,700	26.4	7.4	1.6	68	7.1	49	34	
" "	" "	Sept.	6	17,300	22.5	8.3	1.4	39	6.5	17	23	
" "	" "	Jan. '41	6	73,600	2.7	13.6	2.0	22	6.8	64	26	
" "	" "	Feb. "	3	44,920	2.0	13.8	1.4	42	6.9	32	29	
" "	" "	Mar. "	7	68,030	3.2	13.3	1.6	26	6.8	75	19	
Hocking River - 0.1 Mouth - Hockingport	0 199.3	May	4	611	18.4	8.9	1.0	24	7.2	12	78	
" "	(0.1 mi. abv. mo.Hocking R.)	June	4	1,214	23.4	7.8	1.3	133	7.3	120	64	
" "	" "	July	5	496	25.7	7.6	1.7	68	7.4	98	79	
" "	" "	Aug.	4	632	25.4	7.6	2.1	124	7.4	92	98	
" "	" "	Sept.	2	1,474	20.8	8.3	1.2	24	6.9	20	84	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C.	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 20	0	202.5	May	10	43,130	16.8	9.8	1.6	25	6.7	40	23	
" "	"	"	June	10	71,580	22.2	8.0	1.8	120	7.1	145	31	
" "	"	"	July	12	34,270	24.8	8.2	1.7	62	7.2	69	38	
" "	"	"	Aug.	11	18,530	26.0	7.6	2.0	210	7.2	61	33	
" "	"	"	Sept.	6	18,360	21.9	8.6	1.6	15	6.6	15	24	
" "	"	"	Jan. '41	6	75,380	2.3	13.6	2.2	36	6.8	79	26	
" "	"	"	Feb. "	3	47,030	2.1	13.8	1.6	34	7.0	33	32	
" "	"	"	Mar. "	7	71,380	2.4	13.3	1.9	34	6.7	99	17	
Lock & Dam No. 21	0	214.5	May	10	43,150	15.8	9.6	1.4	11	6.7	37	24	
" "	"	"	June	10	71,760	21.9	7.9	1.8	188	7.1	194	32	
" "	"	"	July	12	34,600	24.3	8.1	1.5	42	7.2	57	39	
" "	"	"	Aug.	11	19,650	26.0	7.6	1.6	19	7.2	41	33	
" "	"	"	Sept.	6	19,290	21.5	8.6	1.5	28	6.6	18	26	
" "	"	"	Jan. '41	6	73,560	2.2	13.1	3.8	33	6.9	64	28	
" "	"	"	Feb. "	3	48,290	2.1	13.6	1.4	41	7.0	32	31	
" "	"	"	Mar. "	8	70,650	2.9	13.3	2.2	26	6.7	64	19	
Lock & Dam No. 22	0	221	May	10	43,140	15.7	9.7	1.4	11	6.7	26	23	
" "	"	"	June	10	72,020	21.3	7.7	1.7	115	7.0	194	31	
" "	"	"	July	11	32,970	23.8	8.0	1.4	29	7.2	57	39	
" "	"	"	Aug.	11	20,300	25.6	7.7	1.7	17	7.2	34	33	
" "	"	"	Sept.	6	19,780	20.9	8.5	1.5	17	6.6	22	24	
" "	"	"	Jan. '41	6	75,310	2.2	13.6	1.8	37	6.8	49	27	
" "	"	"	Feb. "	3	47,460	2.8	13.4	1.6	35	7.0	34	31	
" "	"	"	Mar. "	8	70,490	3.7	13.2	2.0	22	6.7	85	18	
Lock & Dam No. 23	0	231.5	May	8	42,960	16.3	9.8	1.2	8	6.6	30	24	
" "	"	"	June	10	72,200	22.1	7.7	1.7	102	6.9	196	31	
" "	"	"	July	12	34,960	24.4	8.1	1.3	24	7.2	60	36	
" "	"	"	Aug. '40	11	21,350	26.4	7.9	1.7	22	7.2	31	32	
" "	"	"	Sept. "	6	20,620	21.7	8.7	1.9	15	6.6	24	26	
" "	"	"	Jan. '41	5	72,690	2.3	13.6	2.0	30	6.8	43	28	
" "	"	"	Feb. "	3	48,860	2.0	13.8	1.5	19	7.0	40	31	
" "	"	"	Mar. "	8	71,000	3.9	13.2	2.0	18	6.7	63	19	
Pt. Pleasant, W. Va. Above Kanawha River	0	265	Aug. '39	6	12,600	25.8	6.4	1.7	27	7.3	26	38	
" "	"	"	Sept.	7	4,600	24.0	6.7	0.8	9	7.5	4	45	
" "	"	"	Oct.	9	11,100	17.1	8.4	0.8	11	7.4	9	32	
" "	"	"	Nov.	8	11,000	7.8	11.2	1.0	7	7.0	13	29	
" "	"	"	Dec.	7	28,900	4.9	12.7	0.9	22	6.9	8	23	
" "	"	"	Jan. '40	1	9,430	2.5	13.5	1.2	2	7.1	9	20	
" "	"	"	Feb.	5	109,200	2.4	12.8	2.7	29	6.9		29	
" "	"	"	Mar.	7	99,500	5.3	12.8	1.9	36	6.9	155	28	
" "	"	"	Apr.	4	199,400	8.3	10.9	2.2	24	6.8	161	21	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Kanawha River At Mouth	0 265.7	Aug. '39	6	4,100	25.8	5.2	1.6	5	7.3	14	39	
" "	(0.6 mi.abv. mo. Kan. R.)	Sept.	7	1,800	24.1	6.1	0.8	1	7.5	6	50	
" "	" "	Oct.	9	1,600	17.9	7.3	0.7	3	7.5	7	46	
" "	" "	Nov.	8	1,900	7.9	8.5	0.9	2	7.2	8	57	
" "	" "	Dec.	7	2,500	5.0	6.9	1.2	1	7.1	6	64	
" "	" "	Jan. '40	5	2,300	1.9	9.8	2.5	1	7.0	45	54	
" "	" "	Feb.	5	20,200	2.4	12.7	2.1	52	7.0	142	26	
" "	" "	Mar.	7	17,480	5.3	11.5	1.5	34	7.0	62	28	
" "	" "	Apr.	4	28,420	8.8	9.9	1.6	150	6.9	82	23	
Gallipolis Dam	0 279	June	2	39,500	26.8	5.9	1.6	38	7.3	83	31	
" "	" "	July	7	37,800	25.3	6.4	1.2	23	7.3	77	40	
" "	" "	Aug.	10	18,300	25.4	6.2	1.1	11	7.3	33	35	
" "	" "	Sept.	6	6,700	23.8	6.4	0.8	2	7.5	7	47	
" "	" "	Oct.	9	12,900	17.6	7.9	0.6	5	7.5	8	38	
" "	" "	Nov.	7	13,100	8.0	10.8	1.0	5	7.2	11	33	
" "	" "	Dec.	7	26,100	5.3	11.6	0.9	14	7.1	7	28	
" "	" "	Jan. '40	1	12,000	0.8		1.4	2	7.2	9	37	
" "	" "	Feb.	4	126800	2.0	13.1	2.2	22	6.9	175	28	
" "	" "	Mar.	6	95,000	4.2	12.8	1.6	21	6.9	66	29	
" "	" "	Apr.	4	228300	7.8	10.8	2.2	24	6.8	157	20	
Lock & Dam No. 27 Above Guyandot River	0 301	June '39	2	38,700	26.5	7.0	1.9	24	7.3	105	33	
" "	" "	July	7	38,100	26.5	7.2	1.5	31	7.3	95	40	
" "	" "	Aug.	10	19,900	26.4	7.3	1.6	14	7.3	38	33	
" "	" "	Sept.	7	8,200	24.7	7.8	0.8	1	7.5	5	48	
" "	" "	Oct. '39	9	14,200	18.4	8.9	0.8	2	7.5	8	37	
" "	" "	Nov.	7	14,500	9.7	11.6	1.4	4	7.2	11	32	
" "	" "	Dec.	6	29,500	6.5	12.2	1.3	9	7.0	8	29	
" "	" "	Jan. '40	2	37,600	1.0	13.6	1.3	23	6.9	16	26	
" "	" "	Feb.	6	115,400	2.5	13.1	2.5	33	6.9	196	29	
" "	" "	Mar.	7	128,100	4.2	12.6	2.1	36	6.9	140	30	
" "	" "	Apr.	4	232,800	8.1	10.7	3.8	29	6.8	149	22	
Guyandot River-Mouth Cabell Co.Highway Br.	0 305.2	June '39	2	1,010	25.8	6.8	1.1	350	7.2	405	20	
" "	(0.1 mi.abv. mo. Guy. R.)	July	4	1,455	25.3	7.1	1.1	2,950	7.3	286	23	
" "	" "	Aug.	4	345	25.8	6.6	1.1	380	7.4	90	36	
" "	" "	Sept.	5	60	23.6	4.9	2.4	4,600	7.2	15	52	
" "	" "	Oct.	4	41	17.6	5.3	4.0	3,060	7.5	16	48	
" "	" "	Nov.	4	52	8.8	9.5	7.4	3,280	7.1	18	48	
" "	" "	Dec.	4	107	4.4	10.8	3.9	550	7.2	10	59	
" "	" "	Feb. '40	2	3,868	4.0	12.3	1.1	236	7.0	66	17	
" "	" "	Mar. '40	4	1,439	6.5	11.7	0.8	34	6.9	29	19	
" "	" "	Apr.	2	2,958	12.5	10.2	0.7	93	6.6	20	17	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 28 Below Guyandot River	0	312	June '39	4	39,300	27.0	6.9	2.6	31	7.3	76	32	
" "	"	"	July	7	39,500	26.3	7.3	1.9	111	7.3	108	41	
" "	"	"	Aug.	10	20,900	26.5	7.4	1.4	241	7.3	48	33	
" "	"	"	Sept.	7	9,000	24.5	7.3	1.0	660	7.5	6	45	
" "	"	"	Oct.	9	14,900	17.9	8.7	0.9	142	7.5	7	40	
" "	"	"	Nov.	8	15,100	9.0	11.5	1.2	31	7.2	11	32	
" "	"	"	Dec.	7	31,400	5.9	12.2	1.0	9	7.1	8	29	
" "	"	"	Jan. '40	3	38,900	0.9	13.8	1.2	6	7.0	14	27	
" "	"	"	Feb.	4	48,500	2.5	13.7	1.8	18	6.9	78	31	
" "	"	"	Mar.	7	125,700	4.1	12.6	2.0	72	7.0	152	18	
" "	"	"	Apr.	4	244,200	8.5	10.7	2.2	43	6.8	145	20	
N. & W. R. R. Bridge	0	316	June '39	11	39,200	25.6	7.7	1.9	130	7.3	90	33	
" "	"	"	July	10	39,300	25.8	7.6	1.1	177				
" "	"	"	Aug.	11	20,900	26.3	7.6	0.9	218				
" "	"	"	Sept.	10	8,800	24.6	7.5	0.9	175				
" "	"	"	Oct.	11	14,600	16.1	8.9	0.8	169		6	41	
" "	"	"	Nov.	9	15,100	9.8	11.4	1.0	74	7.2	12	36	
" "	"	"	Dec.	10	31,100	5.7	12.4	1.1	33				
" "	"	"	Jan. '40	4	33,600	0.0	14.1	1.0	13	6.9	7	30	
" "	"	"	Feb.	6	142,200	1.8	12.9	2.2	37				
" "	"	"	Mar.	10	136,900	4.1	12.5	1.7	43	6.7	90	27	
" "	"	"	Apr.	5	268,900	7.8	10.8	1.9	44				
Big Sandy River-Mouth	0	317.1	June '39	11	2,560	26.9	6.8	1.5	103	7.3	113	40	
" " "	(0.3 mi.abv. mo.B.Sandy R)		July	10	4,680	26.3	7.0	1.5	61	7.4	256	34	
" " "	"	"	Aug.	11	1,020	26.9	7.4	1.4	22	7.6	37	55	
" " "	"	"	Sept.	10	210	25.6	6.0	1.2	196	7.5	16	71	
" " "	"	"	Oct.	11	109	20.4	6.4	1.2	92	7.7	9	91	
" " "	"	"	Nov.	9	104	12.6	6.1	2.1	54	7.3	11	96	
" " "	"	"	Dec.	10	133	9.4	7.7	2.0	60	7.4	7	100	
" " "	"	"	Jan. '40	3	570	1.3	12.1	1.1	46	7.0	38	73	
" " "	"	"	Feb.	6	5,026	3.4	12.2	1.3	50	7.0	139	27	
" " "	"	"	Mar. '40	10	4,590	6.8	11.4	0.9	76	6.9	77	24	
" " "	"	"	Apr.	5	7,806	11.6	9.9	0.9	59	6.7	82	29	
Lock & Dam No. 29 Below Big Sandy River	0	320	June '39	11	41,900	25.7	7.6	1.7	155	7.3	58	33	
" "	"	"	July	10	42,900	26.0	7.5	1.2	240	7.4	139	36	
" "	"	"	Aug.	11	21,900	26.4	7.6	1.1	280	7.5	41	34	
" "	"	"	Sept.	10	8,900	24.7	7.6	0.9	129	7.6	5	49	
" "	"	"	Oct.	11	14,600	16.6	8.9	0.8	151	7.7	6	41	
" "	"	"	Nov.	9	15,200	10.0	11.3	1.1	72	7.3	11	33	
" "	"	"	Dec.	10	31,000	5.8	12.4	1.0	49	7.2	10	30	
" "	"	"	Jan. '40	4	33,900	0.2	14.2	1.2	21	6.9	11	33	
" "	"	"	Feb.	6	147,100	2.0	12.9	2.2	36	6.9	202	27	
" "	"	"	Mar.	10	141,100	4.0	12.5	1.7	37	6.8	131	27	
" "	"	"	Apr.	5	266,000	7.7	10.8	2.0	42	6.6	143	20	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
At White Oak Creek	0	326	June '39	11	41,500	26.1	7.1	1.5	203	7.2	57	31	
" "	"	"	July	9	42,900	26.1	7.2	1.2	192	7.5	62	38	
" "	"	"	Aug.	12	21,900	26.4	7.5	1.0	306	7.4	47	32	
" "	"	"	Sept.	10	8,900	24.6	7.4	0.9	190	7.4	11	45	
" "	"	"	Oct.	11	14,600	18.5	8.9	0.9	150	7.5	9	40	
" "	"	"	Nov.	9	15,200	10.1	11.6	1.0	76	7.2	9	31	
" "	"	"	Dec.	10	31,000	5.8	12.3	1.1	77	7.0	9	29	
" "	"	"	Jan. '40	3	37,300	0.8	14.1	1.4	33	6.8	22	29	
" "	"	"	Feb.	4	133,900	2.1	12.8	2.7	30	7.0	110	29	
" "	"	"	Mar.	11	129,500	4.1	12.6	1.7	55	6.8	124	25	
" "	"	"	Apr.	4	273,900	8.0	10.9	1.8	64	6.7	158	17	
Hanging Rock Light Above Little Sandy R.	0	330	June '39	11	41,200	25.6	7.4	1.9	167	7.2	60	31	
" "	"	"	July	9	42,400	26.1	7.2	1.2	289				
" "	"	"	Aug.	12	21,800	26.2	7.4	1.0	151				
" "	"	"	Sept.	10	8,300	24.4	7.5	0.9	230				
" "	"	"	Oct. '39	11	13,700	18.3	8.9	0.9	186				
" "	"	"	Nov.	9	15,100	9.8	11.5	1.0	67				
" "	"	"	Dec.	10	29,900	6.1	12.4	1.0	71	7.2	7	32	
" "	"	"	Jan. '40	3	37,300	0.5	14.0	1.1	32				
" "	"	"	Feb.	4	133,900	1.8	12.8	2.6	[illegible]	6.7	260	23	
" "	"	"	Mar.	11	129,500	4.0	12.6	1.5	34				
" "	"	"	Apr.	4	273,900	8.0	10.8	1.7	34				
Coal Branch Light Below Little Sandy R.	0	337	June	11	41,300	25.6	7.2	2.1	225	7.1	67	32	
" "	"	"	July	9	43,100	26.1	7.1	1.4	215	7.3	132	38	
" "	"	"	Aug.	12	21,900	26.1	7.3	1.1	177	7.3	43	33	
" "	"	"	Sept.	10	8,300	24.3	7.5	1.0	52	7.4	5	46	
" "	"	"	Oct.	11	13,800	18.1	[illegible]	0.8	75	7.5	6	40	
" "	"	"	Nov.	9	15,200	9.8	11.3	1.0	96	7.2	9	31	
" "	"	"	Dec.	10	30,000	5.4	12.3	1.1	54	7.1	9	29	
" "	"	"	Jan. '40	3	38,000	0.5	13.9	1.0	27	6.8	21	27	
" "	"	"	Feb.	3	121,000	2.2	13.4	1.8	50				
" "	"	"	Mar.	10	132,400	4.0	12.4	1.5	40	6.8	75	24	
" "	"	"	Apr.	4	276,000	7.6	10.7	1.7	35	6.7	155	17	
Lock & Dam No. 30	0	339	June '39	2	41,200	27.1	6.7	1.9	278	7.4	130	32	
" "	"	"	July	7	43,000	26.9	7.2	1.4	220	7.4	99	36	
" "	"	"	Aug.	9	21,900	26.8	7.5	1.2	95	7.5	33	33	
" "	"	"	Sept.	7	8,300	24.2	7.5	1.1	17	7.5	8	44	
" "	"	"	Oct. '39	9	13,800	18.3	8.8	1.1	48	7.6	8	40	
" "	"	"	Nov.	9	15,200	9.3	11.2	1.2	28	7.2	9	32	
" "	"	"	Dec.	7	30,000	5.5	12.2	1.2	61	7.1	14	29	
" "	"	"	Jan. '40	3	39,600	1.6	13.8	1.5	59	6.9	24	29	
" "	"	"	Feb.	4	132,800	2.0	12.8	2.5	41	7.0	186	30	
" "	"	"	Mar.	8	147,500	4.3	12.2	1.9	34	6.9	148	25	
" "	"	"	Apr.	3	258,900	8.4	11.0	1.7	46	6.6	147	18	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1940	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Scioto River Lucasville Bridge	0 356.5	Jan. '39	9	5,037	4.7	11.5	2.5	200	7.7		173	
" "	(15.5 mi. abv. mo. Scioto R.)	Feb.	7	23,343	3.6	11.9	2.6	333	7.6		117	
" "	" "	Mar.	9	14,244	7.7	10.5	2.1	129	7.6		145	
" "	" "	Apr.	7	12,043	10.9	9.5	1.5	84	7.7		155	
" "	" "	May	5	2,856	17.0	8.9	2.4	26	8.0		226	
" "	" "	June	9	8,390	24.3	6.5	2.2	63	7.8		184	
" "	" "	July	5	3,092	23.7	7.2	1.9	8	7.9		194	
" "	" "	Sept.	5	458	21.7	7.6	3.0	3	8.0	28	222	
" "	" "	Oct.	4	349	15.4	8.2	2.7	3	8.0	24	267	
" "	" "	Nov.	5	571	7.2	10.0	1.8	6	7.9	18	229	
" "	" "	Dec.	3	610	6.2	10.2	1.9	2	7.8	10	229	
" "	" "	Jan. '40	1	405	0.5	10.4	3.7	9	7.6	7	271	
Lock & Dam No. 31 Below Scioto River	0 359	June '39	2	47,500	26.1	6.5	2.3	139	7.4	125	42	
" "	" "	July	8	45,300	25.9	7.1	1.5	79	7.4	90	49	
" "	" "	Aug.	9	22,800	25.5	7.4	1.4	78	7.5	38	43	
" "	" "	Sept.	8	7,900	23.0	7.5	0.9	105	7.6	6	60	
" "	" "	Oct.	9	13,100	17.4	9.0	1.0	76	7.6	9	52	
" "	" "	Nov.	9	15,700	8.2	11.2	1.6	37	7.1	9	36	
" "	" "	Dec.	8	29,000	5.1	12.1	1.3	40	7.1	14	32	
" "	" "	Jan. '40	2	50,000	0.7	13.5	1.7	28	6.9	38	36	
" "	" "	Feb.	5	143,800	1.9	12.6	2.9	76	7.1	191	34	
" "	" "	Mar.	8	147,400	4.3	12.1	1.9	44	6.9	160	26	
" "	" "	Apr.	3	260,800	7.9	11.0	1.8	35	6.6	148	20	
Lock & Dam No. 32	0 383	June '39	2	47,200	26.5	6.4	1.8	138	7.5	80	47	
" "	" "	July	7	44,500	25.9	7.1	1.5	56	7.4	90	49	
" "	" "	Aug.	9	22,700	26.9	7.3	1.3	37	7.4	41	44	
" "	" "	Sept.	7	7,000	24.2	7.5	1.4	3	7.4	10	56	
" "	" "	Oct. '39	9	12,000	17.8	9.0	1.5	7	7.5	11	55	
" "	" "	Nov.	9	15,500	8.8	11.2	1.4	20	7.1	11	39	
" "	" "	Dec.	8	27,900	7.0	11.9	1.2	50	7.1	14	34	
" "	" "	Jan. '40	1	57,900	0.5	13.2	1.8	15	6.7	50	35	
" "	" "	Feb.	3	127,800	2.6	12.6	2.6	86	7.0	145	31	
" "	" "	Mar.	8	164,900	4.1	11.8	2.1	44	6.9	188	28	
" "	" "	Apr.	3	260,300	8.9	10.8	2.4	76	6.6	133	20	
Lock & Dam No. 33	0 405	Feb. '39	3	301,700	5.2	12.1	2.0	106	7.3	165	26	
" "	" "	Mar.	4	216,700	7.3	11.5	2.1	53	7.5	213	34	
" "	" "	Apr.	3	237,100	9.3	10.8	3.5	37	7.5	107	39	
" "	" "	May	3	33,700	16.2	9.8	1.3	16	7.7	23	48	
" "	" "	July	2	44,000	25.8	7.5	2.2	60	7.4	112	50	
" "	" "	Aug.	5	22,500	26.8	7.4	1.8	27	7.4	66	43	
" "	" "	Sept.	3	6,100	24.3	7.6	1.4	154	7.6	99	95	
" "	" "	Oct.	5	11,300	18.4	8.7	1.1	9	7.5	13	58	
" "	" "	Nov.	4	15,800	9.0	11.3	1.4	14	7.3	10	38	
" "	" "	Dec.	3	36,000	7.2	11.9	1.2	29	7.3	11	34	
" "	" "	Jan. '40	1	91,800	0.0	13.7	0.9	9	7.2	8	35	
" "	" "	Feb.	2		2.5	12.7	2.4	48	7.2	260	33	
" "	" "	Mar.	4	131,800	4.3	12.3	2.2	71	7.2	186	31	
" "	" "	Apr.	3	240,300	8.2	11.1	1.9	39	7.1	187	27	

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TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 34	0	434	Feb. '39	6	305,600	4.0	12.0	2.4	97	7.2	257	27	
" "	"	"	Mar.	11	219,900	5.8	11.4	2.7	41	7.5	231	32	
" "	"	"	Apr.	9	238,300	8.5	10.5	1.9	86	7.4	172	34	
" "	"	"	May	9	34,800	17.6	9.5	1.7	10	7.6	21	49	
" "	"	"	June	4	44,400	25.3	7.7	2.7	45	7.6	68	48	
" "	"	"	July	3	43,400	25.9	7.0	1.7	100	7.3	179	47	
" "	"	"	Aug.	5	21,000	25.7	7.2	1.6	117	7.4	113	54	
" "	"	"	Sept.	3	6,600	23.7	7.8	0.8	1	7.6	11	59	
" "	"	"	Oct.	5	10,600	16.6	8.8	1.0	5	7.6	19	60	
" "	"	"	Nov.	4	15,800	8.3	11.4	1.1	7	7.5	12	42	
" "	"	"	Dec.	3	26,000	5.5	11.9	0.9	49	7.3	13	27	
" "	"	"	Jan. '40	1	32,500	0.0	13.4	0.8	11	7.2	16	36	
" "	"	"	Feb. '40	2		2.2	12.4	2.4	52	7.1	245	30	
" "	"	"	Mar.	4	133,500	4.0	11.9	2.2	56	7.3	241	33	
" "	"	"	Apr.	3	238,600	7.3	10.9	2.0	59	7.1	200	32	
Lock & Dam No. 35	0	451	Feb. '39	7	307,800	3.8	11.9	2.4	57	7.2	277	27	
" "	"	"	Mar.	11	221,700	6.1	11.4	2.5	73	7.5	251	32	
" "	"	"	Apr.	10	239,000	8.9	10.5	2.1	39	7.3	209	35	
" "	"	"	May	7	35,300	15.4	9.8	1.6	9	7.6	27	48	
Lock & Dam No. 36	0	461	Feb. '39	6	309,100	3.8	12.0	2.8	130	7.3	274	28	
" "	"	"	Mar.	11	222900	5.8	11.5	2.2	48	7.4	241	29	
" "	"	"	Apr.	8	239500	8.6	10.6	1.8	73	7.2	172	38	
" "	"	"	May	12	35,700	17.4	9.5	1.5	5	7.6	16	50	
" "	"	"	June	11	42,400	24.4	7.5	2.0	57	7.7	102	48	
" "	"	"	July	9	43,400	25.0	7.0	1.7	92	7.2	241	46	
" "	"	"	Aug.	12	19,400	24.0	7.5	1.6	44	7.5	93	46	
" "	"	"	Sept. '39	9	7,000	23.2	8.1	0.9	7	7.7	13	54	
" "	"	"	Oct.	11	10,500	16.5	9.1	0.7	3	7.6	11	63	
" "	"	"	Nov.	10	15,800	8.7	11.3	1.1	7	7.4	18	44	
" "	"	"	Dec.	10	26,100	5.2	12.2	1.2	55	7.3	20	35	
" "	"	"	Feb. '40	5	158,800	1.6	12.5	2.4	133	7.1	237	30	
" "	"	"	Mar.	10	157,400	3.9	11.8	1.9	45	7.3	265	34	
" "	"	"	Apr.	6	256,900	7.9	10.6	1.9	32	7.2	192	27	
Stillwater S.Harbor Abv.L.Miami River	0	462.8	Apr. '39	4	239,600	8.0	11.0	2.1	39				
" "	"	"	May	4	35,800	22.3	9.4	2.0	2				
" "	"	"	June	10	42,200	25.3	7.7	2.3	33				
" "	"	"	July	8	42,800	26.3	7.1	1.9	442				
" "	"	"	Aug.	12	19,400	26.5	7.8	1.5	38				
" "	"	"	Sept.	8	7,100	25.0	8.4	1.1	5				
" "	"	"	Oct.	11	10,300	18.3	9.3	1.0	5				
" "	"	"	Nov.	9	15,800	9.6	12.0	1.4	4				
" "	"	"	Dec. '39	7	26,100	6.1	12.4	1.4	30				
" "	"	"	Apr. '40	4		8.5	10.3	2.1	100				

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage from Pittsburgh	Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
L.Miami River - Mouth Beechmont Bridge	0 464.1	Feb. '39	2	8,000	2.5	12.5	2.1	240				
" "	(4.3 mi.abv. mo.L.Miami R)	Mar.	4	2,800	6.6	11.3	1.9	88				
" "	" "	Apr.	4	3,100	9.3	10.2	1.8	348				
" "	" "	May	5	500	18.4	7.6	2.9	920				
" "	" "	June	4	5,000	22.3	6.3	4.3	2,580				
" "	" "	July	2	200	21.8	5.7	7.6	4,600				
" "	" "	Aug.	2	200	24.5	5.8	4.3	3,300	7.8			
" "	" "	Sept.	2	200	19.8	2.3	6.1	2,520	7.5			
" "	" "	Oct.	2	80	15.5	3.3	7.9	6,650	7.6			
" "	" "	Nov.	2	140	7.0	7.9	11.5	4,450	7.6			
" "	" "	Dec.	1	167	3.5	12.0	7.5	1,100	7.9			
" "	" "	Jan. '40	4	269	0.0	12.3	4.8	2,880	7.7	170		
" "	" "	Feb.	4	1,210	2.0	13.3	3.6	394	7.8			
" "	" "	Mar. '40	4	1,390	5.9	12.0	2.0	324	7.7			
" "	" "	Apr.	7	881	11.1	Not Run	1.8	284	7.7	173	118	
Marmet's Landing	0 465.3	Apr. '39	4	245,900	8.3	10.9	2.2	146				
L. & N. R.R. Bridge Above Licking River	0 469.5	Apr. '39	8	146,700	8.1	11.0	2.0	78				
" "	" "	May	9	36,500	22.2	9.1	1.9	51				
" "	" "	June	19	43,600	25.1	7.4	2.5	196				
" "	" "	July	16	43,800	26.0	7.0	1.8	312				
" "	" "	Aug.	23	19,400	26.4	7.5	1.7	499				
" "	" "	Sept.	16	7,300	24.8	8.1	1.7	499				
" "	" "	Oct.	22	10,500	16.2	9.0	1.6	604				
" "	" "	Nov.	16	16,000	9.5	11.9	1.8	226				
" "	" "	Dec.	18	26,200	6.1	12.4	1.8	246				
" "	" "	Apr. '40	8		8.7	10.4	1.8	56				
Licking R..8mi.above mouth Banklick Creek	0 470.2	June '39	1	2,630		6.8	2.0	460	7.8	550	94	
" "	(5.5 mi.abv. mo.Licking R)	July	2	14,140	24.0	6.3	2.2	235				
" "	" "	Aug.	2	2,020	23.8	6.5	1.6	45	7.5			
" "	" "	Sept.	2	80	22.3	6.5	1.4	5	7.8			
" "	" "	Oct.	2	60	15.8	8.0	1.5	3	7.8			
" "	" "	Nov.	2	190	5.5	11.4	1.1	4	7.6			
" "	" "	Dec.	2	128	2.0	12.2	2.0	9	7.6			
" "	" "	Jan. '40	2	3,990	0.0	13.4	3.7	57	7.6			
" "	" "	Feb.	3	10,950	2.8	12.5	3.8	125	7.5			
" "	" "	Mar.	5	14,270	7.6	12.8	1.5	27	7.6			
Licking R.-L.&N.Br. near Latonia, Ky.	0 470.2	Apr. '39	4	11,230	12.9	9.9	1.1	179				
" "	(3.3 mi.abv. mo.Licking R)	May	5	1,380	21.6	8.3	2.0	285				
" "	" "	June	2	2,600	23.5	6.4	2.6	285				
Licking R. - Mouth	0 470.2	Feb.	1	7,370	6.0	11.7	1.6	150				
" "	(0.2 mi.abv. mo.Licking R)	Mar.	4	22,630	9.3	10.6	3.0	167				
" "	" "	Mar. '40	5	14,270	9.2	11.1	1.9	555	7.6			
Southern Ry. Bridge Below Licking River	0 472.3	Apr. '39	4	265,000	8.3	11.0	2.1	56				

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh		Period 1939–40	Number of Samples	Average Discharge c.f.s.	Temp °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Riverside	0	475.2	May	4	38,400	22.6	7.9	2.9	2,530				
"	"	"	June	9	45,200	24.8	6.6	3.0	1,850				
"	"	"	July	9	50,700	25.8	6.6	2.2	2,270				
"	"	"	Aug.	11	20,700	26.3	6.3	2.3	5,140				
"	"	"	Sept.	8	7,700	24.9	3.9	2.9	32,600				
"	"	"	Oct.	11	10,500	18.4	6.2	2.9	60,800				
"	"	"	Nov.	7	16,100	9.5	11.1	3.3	4,300				
"	"	"	Dec.	10	26,400	5.9	11.9	3.7	1,490				
"	"	"	Apr. '40	4	277,500	8.7	10.4	2.0	402				
Anderson's Ferry	0	477.5	Apr. '39	5	265,300	8.2	10.9	2.3	94				
Lock & Dam No. 37	0	483	Feb.	8	349,200	3.7	11.8	2.5	67	7.5	333	38	
" "	"	"	Mar.	12	345,600	5.9	11.3	2.3	132	7.5	325	36	
" "	"	"	Apr.	10	265,300	9.3	10.4	1.9	281	7.3	194	38	
" "	"	"	May	10	38,400	18.5	8.8	2.7	1,630	7.7	21	61	
" "	"	"	June	10	45,200	25.8	6.4	3.4	2,040	7.9	98	59	
" "	"	"	July	10	50,700	26.7	6.3	2.2	1,960	7.3	240	57	
" "	"	"	Aug.	11	20,700	26.6	5.4	2.2	5,830	7.5	90	54	
" "	"	"	Sept.	11	7,700	24.7	3.8	1.9	913	7.4	12	62	
" "	"	"	Oct.	11	10,500	18.0	5.7	1.7	12,000	7.4	11	67	
" "	"	"	Nov.	11	16,100	8.9	10.6	2.4	1,700	7.3	17	44	
" "	"	"	Dec.	10	26,400	5.4	11.4	3.6	1,980	7.2	20	40	
" "	"	"	Feb. '40	3	143,900	3.7	12.4	3.1	80	7.2	232	38	
" "	"	"	Mar.	11	151,100	5.1	11.7	2.6	110	7.3	190	35	
" "	"	"	Apr.	12	369,200	9.0	10.4	3.9	144	7.1	268	30	
Miami River - Mouth West of Cleves	0	491.1	Mar. '39	4	10,600	6.4	11.6	4.4	265	8.2	85	244	
" "	(4.2 mi.abv. mo.Miami R.)		Apr.	3	4,400	12.2	9.7	2.9	175	8.0	40	239	
" "	"	"	May	4	2,100	19.3	9.4	[illegible].4	131	8.1	22	245	
" "	"	"	June	5	5,100	24.9	7.5	4.1	325	8.0	171	213	
" "	"	"	July	6	4,300	24.8	7.3	4.1	1,680	7.8	809	195	
" "	"	"	Aug.	7	1,000	24.8	8.0	4.0	376	8.1	102	208	
" "	"	"	Sept.	6	700	21.8	8.3	4.0	41	8.0	28	227	
" "	"	"	Oct.	7	600	15.6	8.6	4.5	50	7.9	16	236	
" "	"	"	Nov.	6	700	6.9	9.6	3.2	190	7.7	18	246	
" "	"	"	Dec.	6	910	5.8	9.7	3.2	90	7.7	12	250	
" "	"	"	Jan. '40	2	2,560	0.5	12.7	4.1	252	7.7	195	215	
" "	"	"	Feb.	5	7,290	2.6	11.8	5.5	243	7.8	318	171	
" "	"	"	Mar.	6	9,630	5.5	10.7	3.9	2,290	7.9	153	198	
" "	"	"	Apr.	4	4,220	11.0	9.2	4.8	433	7.9	65	226	
Lock & Dam No. 38	0	503.3	Feb.	9	363,400	3.6	11.8	3.1	438	7.4	39	308	
" "	"	"	Mar.	12	262,100	5.7	11.2	2.6	430	7.7	325	44	
" "	"	"	Apr.	10	285,800	9.6	10.3	2.2	294	7.3	204	45	
" "	"	"	May	10	42,000	19.3	9.0	2.5	924	7.7	22	70	
" "	"	"	June	11	54,400	24.9	6.6	2.6	763	8.0	113	70	
" "	"	"	July	10	55,900	26.0	6.1	2.4	1,020	7.4	271	61	
" "	"	"	Aug.	11	24,300	26.0	6.3	1.8	338	7.6	85	67	
" "	"	"	Sept.	11	8,400	23.8	6.5	2.1	85	7.6	13	[illegible]	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No. 38	0 503.3	Oct.	11	11,800	27.1	6.5	1.9	412	7.5	10	85	
" "	" "	Nov.	11	16,800	8.6	10.2	2.3	2,140	7.3	17	54	
" "	" "	Dec.	10	27,300	4.9	11.3	2.7	1,200	7.2	25	46	
" "	" "	Feb. '40	3	163,300	2.6	12.3	3.7	156	7.3	217	47	
" "	" "	Mar.	10	165,800	4.4	11.6	2.3	110	7.3	202	38	
" "	" "	Apr.	5	280,100	9.3	10.2	2.9	96	7.2	244	33	
Lock & Dam No. 39	0 531.7	Feb.	10	366,200	4.2	11.7	3.2	96	7.4	384	39	
" "	" "	Mar.	12	267,300	6.8	11.2	3.3	149	7.7	368	47	
" "	" "	Apr.	10	293,400	9.9	10.3	2.7	201	7.3	204	47	
" "	" "	May	8	42,800	17.7	9.3	2.4	218	7.8	27	72	
" "	" "	June	4	56,300	25.6	6.1	2.6	284	7.9	98	73	
" "	" "	July	4	57,500	26.4	6.2	2.1	105	7.2	219	59	
" "	" "	Aug.	4	25,800	26.8	6.3	1.4	201	7.5	72	61	
" "	" "	Sept.	5	8,100	24.6	8.6	2.4	2	7.8	13	81	
" "	" "	Oct.	4	12,400	18.3	8.2	1.9	13	7.6	6	87	
" "	" "	Nov.	5	16,400	9.7	10.5	2.2	573	7.2	18	59	
" "	" "	Dec.	4	27,400	5.0	11.4	2.4	520	7.3	21	45	
" "	" "	Mar. '40	5	142,000	4.8	11.6	2.2	200	7.3	167	44	
" "	" "	Apr.	2	300,100	8.0	9.9	2.7	174	7.3	290	32	
" "	" "	July	4	36,400	26.9	7.2	2.7	207	7.5	17	53	
" "	" "	Oct.	2	13,200	18.0	12.1	3.2	78	8.3	10	57	
" "	" "	Jan. '41	3	75,000	3.7	12.6	3.7	338	7.3	61	50	
Kentucky River-Mouth Carrollton, Kentucky	0 545.8	Mar.	5	27,600	8.7	11.1	1.5	35	7.9	393	66	
" "	(0.2 mi.abv. mo.Kentucky R.)	Apr.	3	18,800	11.0	11.4	1.4	29	7.6	218	65	
" "	" "	May	4	3,900	19.5	9.1	3.0	3	7.9	37	85	
" "	" "	June	5	4,500	25.0	7.5	2.0	30	7.8	187	80	
" "	" "	July	4	18,800	26.3	7.1	2.6	204	7.3	565	62	
" "	" "	Aug.	4	2,900	25.9	6.3	1.6	25	7.5	201	83	
" "	" "	Sept.	5	1,000	25.1	7.4	1.2	4	7.7	13	93	
" "	" "	Oct.	4	600	19.1	6.3	1.0	3	7.5	9	102	
" "	" "	Nov.	5	700	10.2	8.9	1.4	5	7.5	15	94	
" "	" "	Dec.	4	800	5.2	10.7	1.4	16	7.5	17	100	
" "	" "	Feb. '40	4	10,000	4.3	12.8	1.4	21	7.6	159	76	
" "	" "	Mar.	5	33,900	6.9	11.4	1.5	34	7.5	323	60	
" "	" "	Apr.	1	1,200	13.0	10.3	1.4	24	7.3	310	54	
" "	" "	July	4	3,500	26.5	7.4	1.8	28	7.5	80	61	
" "	" "	Oct.	2	200	17.8	8.5	1.6	57	7.6	14	61	
" "	" "	Jan. '41	3	1,700	5.0	12.3	3.1	20	7.4	73	79	110
Notch Lick Light	0 547.8	July	4	43,900	26.6	7.9	2.2	186	7.5	26	55	
" "	" "	Oct.	2	13,800	17.9	11.8	2.9	24	8.5	20	54	
" "	" "	Jan. '41	3	79,600	3.9	12.7	3.5	87	7.3	61	50	
Crooked Creek Upper Light	0 559.5	July	2	35,100	29.0	8.5	2.6	94	7.6	15	54	
Clifty Creek Lower Light	0 561	July	2	40,100	26.1	7.9	2.2	1,260	7.5	29	55	
" "	" "	Oct.	2	11,700	19.5	11.2	3.1	58	8.4	18	54	
" "	" "	Jan. '41	3	89,200	3.4	12.5	3.4	199	7.3	54	55	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lower Hanover Landing	0 562.6	July	2	35,100	29.0	8.3	2.1	218	7.6	15	53	
" "	" "	Oct.	2	11,700	19.4	11.4	2.7	17	8.5	10	51	
" "	" "	Jan. '41	3	89,200	3.3	12.5	3.5	60	7.3	59	55	
Jobson Landing	0 576.1	July	4	37,600	27.3	8.3	2.2	113	7.5	13	54	
" "	" "	Oct.	2	11,700	18.7	10.1	2.9	3	8.0	11	49	
Jobson Landing	0 576.1	Jan. '41	3	89,200	3.1	12.6	3.2	108	7.3	59	55	
Six Mile Island Light	0 597.9	Aug.	1	36,200	29.5	9.4	2.8	9	8.1	12	52	
Louisville Water Wks.	0 600.0	Aug.	3	26,900	29.4	8.8	2.2	44	8.1	9	55	
" " "	" "	Jan. 31-Feb. 5	5	128,100	2.6	12.6	1.6	143	7.2	95	50	
Louisville Highway Br.	0 603.5	Aug	1	36,200	29.5	9.0	2.4	930	8.1	12	53	
New Albany Water Works	0 608.5	Aug.	4	25,300	28.4	8.2	2.6	997	8.0	13	53	
" "	" "	Oct.	2	13,300	17.8	7.3	1.6	695	7.6	8	54	
" "	" "	Feb. '41	[illegible]	[illegible]01,200	2.0	13.1	1.7	142	7.2	74	46	
Falling Run Light	0 610	Aug.	4	25,300	28.8	8.2	2.3	3,220	8.1	11	57	
" "	" "	Oct.	2	13,300	17.9	7.3	2.3	765	7.5	8	53	
" "	" "	Feb. '41	3	101,200	2.1	13.0	1.6	258	7.2	71	46	
Hughes Bar Upper Light	0 614	Aug.	4	25,300	28.3	8.1	2.6	3,480	8.0	10	56	
" "	" "	Oct.	2	13,300	17.5	7.2	2.4	765	7.5	9	52	
" "	" "	Feb. '41	3	101,200	2.1	13.1	4.2	87	7.2	74	45	
Kosmosdale, Kentucky	0 627.1	Aug.	4	23,300	28.8	8.6	2.3	105	8.2	10	57	
Stove Green Landing Light	0 627.9	Oct.	5	11,500	16.2	7.9	2.0	376	7.5	6	50	
" "	" "	Feb. '41	5	66,100	1.2	12.9	2.5	141	7.3	47	55	
Salt River Above mouth	0 629.9	Aug.	3	246	27.7	3.5	2.0	845	7.5	60	123	124
" "	(0.1 mi. abv. mo. Salt R.)	Oct.	5	230	15.8	8.3	2.1	27	7.5	17	67	114
" "	" "	Feb. '41	5	753	2.2	12.7	1.1	32	7.8	14	170	186
Lock & Dam No. 43	0 633.2	Aug.	4	23,400	28.6	8.6	2.6	740	8.2	11	59	
" "	" "	Oct.	5	11,200	16.5	8.4	2.1	107	7.6	6	50	
" "	" "	Feb. '41	5	67,700	1.6	13.0	3.2	153	7.3	45	53	
Rock Haven Upper Light	0 637.1	Oct.	5	11,200	16.8	None	None	63	7.6		51	116
" "	" "	Feb. '41	5	67,700	1.6	12.8	2.4	195	7.3	45	55	
Falling Spring Lower Light	0 639.1	Oct.	5	11,200	16.6	None	None	67	7.6		50	
" "	" "	Feb. '41	5	67,700	1.6	12.9	1.6	246	7.3	44	52	
Lock & Dam No. 44	0 662	Aug.	4	67,200	26.5	7.5	2.7	63	7.8	30	56	
" "	" "	Feb. '41	2	44,500	3.9	13.0	1.8	23	7.2	30	60	
Indian Hollow Light	0 665	Aug.	4	67,200	27.2	7.5	2.4	73	7.9	32	56	
" "	" "	Feb. '41	2	44,500	3.7	13.3	1.7	96	7.3	30	60	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lock & Dam No 45	0 703	Aug.	4	64,700	27.2	7.3	2.3	90	7.9	30	60	
" "	" "	Feb. '41	2	42,800	3.7	13.1	1.5	16	7.3	30	55	
Cloverport Light	0 711.3	Aug.	2	67,500	26.8	7.0	2.1	78	7.6	33	54	
" "	" "	Feb. '41	3	49,900	2.1	13.1	2.6	65	7.3	33	56	
Hancock Bend Lower Light	0 728.7	Aug.	2	80,100	27.0	6.8	2.0	78	7.6	31	54	
" "	" "	Feb. '41	3	45,600	2.1	13.1	3.0	14	7.3	33	58	
Troy Hill Light	0 730.6	Aug.	4	58,800	27.6	6.8	2.2	51	7.8	34	60	
" "	" "	Feb. '41	3	45,600	2.2	13.1	3.3	96	7.3	36	57	
Owensboro Water Works Intake	0 756.5	Aug. 26– Sept. 5	5	56,200	25.7	8.1	2.0	37	7.9	28	53	
" "	" "	Oct.	2	10,400	16.7	9.8	2.6	4	8.1	10	61	
" "	" "	Feb. '41	2	71,500	1.0	13.1	3.6	29	7.3	30	64	
Lock & Dam No. 46	0 757	Aug.	1	18,100	27.2	9.4	2.2	4	8.4	10	57	
Larkin Ferry Light	0 760	Aug. 26– Sept. 5	5	56,200	25.7	8.1	2.1	35	7.9	29	53	
" "	" "	Oct.	2	10,400	16.7	9.6	2.2	97	8.0	9	60	
" "	" "	Feb. '41	2	71,500	0.5	13.4	1.1	16	7.3	32	63	
Lock & Dam No. 47	0 777.7	Aug. 26– Sept. 5	5	55,400	25.8	8.4	1.9	66	8.0	29	55	
" "	" "	Oct.	2	9,700	16.8	8.9	2.0	16	8.0	11	63	
" "	" "	Feb. '41	2	70,600	1.1	[illegible]	1.2	17	7.3	33	60	
Green River Spottsville Bridge	0 784.2	Aug. [illegible]– Sept. 4	3	1,097	26.7	7.0	1.4	1	7.7	18	104	102
" "	(8.6 mi. abv. Mo. Green R.)	Oct.	2	667	17.5	8.3	0.5	1	7.8	13	126	125
" "	" "	Feb. '41	2	3,290	4.0	12.5	0.8	2	7.6	58	91	128
Evansville Water Works Intake	0 791	Aug. 27– Sept. 5	5	57,100	25.9	8.3	2.1	22	8.0	28	57	
" "	" "	Oct.-Nov	2	15,800	17.7	9.2	2.1	24	8.0	12	64	
" "	" "	Feb. '41	2	71,100	0.8	13.4	1.7	16	7.4	33	65	
Dutch Bend Light	0 797.7	Aug. 27– Sept. 6	4	62,100	26.5	8.[illegible]	1.7	106	7.9	32	55	
" "	" "	Oct. 29– Nov. 1	2	14,200	17.5	9.1	2.[illegible]	350	8.1	13	64	
" "	" "	Feb. '41	2	48,700	0.8	13.4	1.[illegible]	9	7.4	29	72	
Henderson Water Works Intake	0 803	Aug. 27– Sept. 6	4	62,10[illegible]	26.5	8.2	1.7	199	7.9	35	56	
" "	" "	Oct. 29– Nov. 1	2	14,200	17.7	9.4	2.8	142	8.2	12	64	
" "	" "	Feb. '41	2	48,700	0.8	13.4	1.1	9	7.4	29	70	
Lock & Dam No. 48	0 809	Aug. 27– Sept. 6	4	62,100	26.4	8.3	1.5	356	7.9	36	56	
" "	" "	Oct. 29– Nov. 1	2	14,200	17.6	9.5	2.3	58	8.2	13	66	
" "	" "	Feb. '41	2	48,700	0.8	13.3	1.1	24	7.4	26	70	
Mount Vernon Water Works	0 829.1	Sept.	4	19,700	23.2	9.0	2.1	19	7.9	18	53	
" "	" "	Nov.	2	47,000	15.3	9.8	2.2	142	7.8	13	61	
" "	" "	Feb. '41	2	31,400	2.3	13.6	3.7	[illegible]	7.5	13	78	
Lock & Dam No. 49	0 845	Sept.	4	19,700	24.0	9.1	1.7	29	7.9	15	56	
" "	" "	Nov.	2	47,000	15.3	9.6	2.[illegible]	77	7.8	13	60	
" "	" "	Feb. '41	2	31,400	2.1	13.6	2.7	28	7.4	16	82	
Wabash River At Mouth	0 848.0	Sept.	4	3,000	22.4	7.4	2.5	2	8.3	55	198	170
" "	(0.1 mi. abv. Mo. Wabash R.)	Nov.	2	3,010	14.0	10.1	2.7	4	8.3	19	213	190
" "	" "	Feb. '41	2	6,[illegible]	2.0	14.2	3.3	1	8.1	16	202	196

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1939–40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Browns Light	0 852.3	Sept.	4	19,700	24.1	9.2	2.0	19	8.0	17	72	
" "	" "	Nov.	2	50,000	15.8	9.7	2.4	20	7.7	14	63	
" "	" "	Feb. '41	2	38,700	2.0	13.9	2.8	8	7.6	16	89	
Greens Crossing Upper Light	0 864.8	Sept.	4	26,700	23.3	9.2	2.0	11	8.0	14	76	
" "	" "	Nov.	3	46,400	15.0	9.9	2.0	26	7.8	13	68	
" "	" "	Feb. '41	2	37,600	1.8	13.1	3.4	5	7.6	16	102	
DeKoven Light	0 870.7	Sept.	4	23,700	23.3	9.3	1.5	5	8.1	14	71	
" "	" "	Nov.	3	46,800	14.9	9.8	1.9	19	7.8	14	64	
" "	" "	Feb. '41	2	36,100	1.8	13.9	2.7	6	7.6	14	92	
Lock & Dam No. 50	0 876.8	Sept.	4	23,800	23.1	9.2	1.6	3	8.1	14	67	
" "	" "	Nov.	3	47,000	14.8	10.0	2.0	9	7.8	13	64	
" "	" "	Feb. '41	2	37,600	1.8	13.8	2.8	5	7.6	14	86	
Rosiclaire	0 891.6	Sept. 20- Oct. 1	4	27,700	21.2	9.2	2.0	62	8.3	12	76	
"	" "	Nov.	2	38,900	8.8	13.2	3.4	5	8.3	19	76	
"	" "	Mar. '41	3		2.8	13.8	2.1	2	7.6	17	86	
Golconda Water Works	0 902.5	Sept. 20- Oct. 1	4	27,700	21.5	9.3	1.8	4	8.3	11	72	
" "	" "	Nov.	2	38,900	8.3	13.4	3.4	3	8.3	19	75	
" "	" "	Mar. '41	3		2.7	13.8	2.7	1	7.6	18	88	
Old Maids Crossing Light	0 918	Sept. 20- Oct. 1	4	28,400	21.1	9.3	1.8	3	8.3	12	72	
" "	" "	Nov.	2	41,200	8.8	13.0	3.3	1	8.2	19	74	
" "	" "	Mar. '41	3		3.1	13.8	2.2	1	7.6	19	88	
Cumberland River Above Mouth	0 920.4	Sept. 20- Oct. 1	4	1,530	21.3	7.8	1.5	2	7.8	24	78	82
" "	(2.8 mi. abv. mo. Cumb. R.)	Nov.	4	2,650	8.9	9.9	1.2	5	7.4	32	89	96
" "	" "	Mar. '41	3	7,197	5.7	13.0	1.5	2	7.6	22	86	112
Ledbetter Light	0 927.3	Sept. 20- Oct. 1	4	30,400	21.7	9.3	1.8	2	8.3	12	77	
" "	" "	Nov.	2	45,900	8.9	13.0	3.2	1	8.2	18	77	
" "	" "	Mar. '41	3		3.2	13.7	2.1	1	7.6	18	89	
Paducah Water Works	0 934.3	Sept.	4	28,000	22.4	8.5	1.6	4	7.9	14	66	
" "	" "	Nov.	2	41,800	11.0	11.7	5.1	3	7.8	24	62	
" "	" "	Mar. '41	3		6.3	13.1	2.1	3	7.6	41	74	
Tennessee River Norton's Bluff Bridge	0 934.5	Sept. 21- Oct. 1	4		22.3	8.2	0.8	1	7.7	10	59	72
" "	(5.3 mi. abv. mo. Tenn. R.)	Nov.	4		8.9	10.2	0.7	4	7.2	37	51	94
" "	" "	Mar. '41	3		6.5	13.1	1.6	1	7.7	36	65	86
Lock & Dam No. 52	0 938.9	Sept.	4	94,600	22.6	8.6	1.2	5	7.9	12	68	
" "	" "	Nov.	2	74,900	10.7	12.0	2.9	5	7.9	24	65	
" "	" "	Mar. '41	3		4.8	13.4	2.1	1	7.6	28	82	
Lock & Dam No. 53	0 962.6	Sept.	4	94,600	20.6	8.7	1.6	37	8.0	16	69	
" "	" "	Nov.	2	74,900	10.1	12.8	2.1	7	8.0	[illegible]	69	
" "	" "	Mar. '41	3		4.6	13.6	2.0	4	7.7	57	83	

TABLE Oh-7 MAIN OHIO RIVER

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF AVERAGES

Sampling Point	Mileage From Pittsburgh	Period 1939-40	Number of Samples	Average Discharge c.f.s.	Temp. °C	D.O. p.p.m.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Cairo W.Wks. Intake	0 978	Oct.	3	52,400	19.8	9.4	1.7	11	8.0	12	74	
" "	" "	Nov.	2	86,700	9.3	11.6	2.5	6	7.7	73	70	
" "	" "	Mar. '41	2		5.0	12.8	2.4	7	7.6	48	74	
Cairo Point	0 981	Oct.	3	52,400	19.6	8.9	1.7	89	7.9	92	91	
" "	" "	Nov.	2	86,700	8.3	11.4	2.7	45	7.7	678	117	
" "	" "	Mar. '41	2		4.2	12.6	2.4	102	7.6	95	100	
Mississippi River Cairo Highway Bridge	M	Oct.	3		18.6	8.0	2.1	434	7.9	343	163	
" "	"	Nov.	2		6.8	10.9	3.5	142	7.7	1,200	163	143
" "	"	Mar. '41	2		3.8	11.8	3.8	262	7.7	172	146	146
Mississippi R.-below mouth of Ohio River Wickliffe, Kentucky	M	Oct.	3		19.2	8.9	1.4	48	7.9	157	104	
" "	"	Nov.	2		9.3	11.4	2.6	13	7.7	258	85	120
" "	"	Mar. '41	2		4.6	12.8	2.0	94	7.7	82	[illegible]	

* Seeded and neutralized

** Less than one.

o Only one result

Only two results.

Table Oh-7A Main Ohio River -Laboratory Data - Acid Stream Results

Sampling Point	Month 1940	No. Samples	pH	ACIDITY P.P.M. Methyl Red	ACIDITY P.P.M. Phenolphthalein Hot	ACIDITY P.P.M. Phenolphthalein Cold	IRON P.P.M. Ferrous	IRON P.P.M. Total
sworth Dam le 6	Sept.	1	5.4	1	12	7		0.4
	Oct.	11	5.6	3.5(2)		11		0.9
	Nov.	9	6.2	5 (1)		12 (2)		3.0
shield Dam le 13.5	Sept.	1	4.7	10	23	17		0.4
	Oct.	11	5.6	3 (1)	11 (1)	10		1.2(4)
	Nov.	9	6.2		12 (2)			
ntgomery Dam le 31.7	Sept.	2	4.7(1)	6 (1)	18 (1)	13 (1)		0.3
	Oct.	11	5.4(7)	4.5(2)	17 (2)	9 (7)		3.2(4)
	Nov.	9	5.9(1)			12 (1)		1.0(1)
m #7 - Mile 36.5	Sept.	2	4.8(1)	7 (1)	18 (1)	15 (1)		0.4
	Oct.	11	5.4(7)	6 (2)	18 (2)	11 (7)		0.7
	Nov.	9	5.7(2)			10 (2)		5.0
m #8 - Mile 46.4	Oct.	12	5.4(6)	4.2(3)	18 (2)	11 (6)	0.6(1)	1.5
	Nov.	9	5.7(2)			10 (2)		3.0
m #9 - Mile 56.1	Oct.	12	5.1	5.3(3)	16 (2)	9 (6)		1.3
	Nov.	9	5.7(2)			10 (2)		
m #10 - Mile 66	Oct.	12	5.9(7)	4.0(5)	14 (2)	10 (7)	0.2(1)	0.7(6)
	Nov.	10	4.9(2)	4.5(2)		14 (2)		
m #11 - Mile 77	Oct.	12	5.0(9)	6.3(6)	17 (3)	13 (9)		2.2(6)
	Nov.	10	5.0(2)	5.0(1)		14 (2)		
m #12 - Mile 87.5	Oct.	12	5.0(9)	3.4(7)	20 (2)	12 (9)	0.4(1)	3.0
	Nov.	10	5.3(2)	3.0(1)	(2)	11 (2)		
m #13 - Mile 96	Oct.	12	5.0(9)	4.3(7)	13 (2)	12 (9)	0.5(2)	2.0
	Nov.	10	5.5(2)			10 (2)		2.8(2)
m #14 - Mile 114	Aug.	11	4.6(9)	7 (9)	12 (6)	12 (9)		0.2
	Sept.	5	4.6	4	12	10		0.3
m #15 - Mile 129	Aug.	11	4.8(7)	2 (4)	12 (7)	7 (7)		0.4
	Sept.	5	4.7	4	13	9		0.4
m #16 - Mile 146.5	Aug.	11	5.0	3 (3)	10 (6)	7 (6)		0.7
	Sept.	5	4.8	3 (4)	12	8		0.2
m #17 - Mile 167.5	Aug.	11	5.5	2 (1)	10	8		0.2
	Sept.	5	4.9(4)	3 (3)	10 (4)	7 (4)		0.3

Note:- Figures in parentheses indicate number acid samples used in computing averages as shown.

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MINOR TRIBUTARY BASINS

Final Report to the Ohio River Committee

Ohio River Pollution Survey

U. S. Public Health Service
Cincinnati, Ohio
1942

145-A

MINOR TRIBUTARY BASINS

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Note: For maps of Minor Tributary Basins see Main Ohio River Summary.

MINOR TRIBUTARY BASINS*

Syllabus and Conclusions

Syllabus

Minor tributaries of the Ohio drain 23,780 square miles (about one-ninth of the entire Ohio Basin) in the six states bordering the main stream. Less than 10% of the 1,400,000 population in the area are in urban communities. Agriculture is the predominant occupation. Coal mining is important in the upper portion of the basin above Marietta, Ohio, and the Saline and Tradewater Basins in Illinois and Kentucky.

Most of the larger communities have sewage treatment plants and there is little organic industrial waste. Acid mine drainage causes the most serious pollution. (See separate section of report on Acid Mine Drainage).

Conclusions

(1) Forty-four of the 94 public water supplies in the area drained by minor tributaries of the Ohio River are from surface sources. Nine of these, serving 24,600 people, are from streams subject to pollution.

(2) Sewage from 173,500 people and industrial wastes equivalent in oxygen demand to sewage from an additional 31,200 people are discharged to minor tributaries of the Ohio. About two-thirds of the sewage receives treatment.

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* For maps of this area, see main Ohio River.

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(3) Laboratory data indicate many instances of heavy local pollution, particularly on very small streams. At the time of sampling the streams generally were in good sanitary condition at their confluence with the Ohio River except where they were influenced by wastes from Ohio River communities. Many of the tributaries in the upper part of the basin, and several small streams in the Saline and Tradewater Basins, were found to be heavily polluted by acid mine drainage.

(4) Abatement of pollution due to sewage and organic industrial wastes will require secondary treatment in most instances because the receiving streams are generally small and subject to extremely low flows.

(5) Reduction in acidity in the minor tributaries can best be accomplished in connection with a program of mine sealing covering the entire Ohio Basin.*

(6) One of the proposed tributary reservoirs authorized by the Congress and studied by the U. S. Engineer Department for Ohio River flood control is on a minor tributary. Low-flow regulation by this reservoir would have no appreciable tangible value for pollution abatement.

(7) The following cost estimates of measures for abatement of pollution due to sewage and industrial wastes are summarized from Table M-1:

Treatment	Capital Cost	Annual Charges
Existing	$3,800,000	$330,000
Suggested Additional	2,590,000	285,000

Estimated additional costs over existing charges of programs involving uniform treatment throughout the basin area:

Primary, all places	2,220,000	250,000
Secondary, all places	3,010,000	335,000

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* See section of report on Acid Mine Drainage.

Table M-1 Minor Tributary Basins - Estimated Cost of Existing and Suggested Minimum Corrective Measures for Sewage and Industrial Wastes, with Comparative Costs for Primary and Secondary Treatment.

	Number of Plants Prim.	Number of Plants Sec.	Population Connected to Sewers	Capital Investment (Dollars)	Annual Charges (Dollars) Amort. & Interest	Annual Charges (Dollars) Operation & Main.	Annual Charges (Dollars) Total
Existing Sewage Treatment	12	30	110,300	3,800,000	225,000	105,000	330,000
Suggested Minimum Correction							
Sewage Treatment Plants	17	23	96,400	1,420,000	100,000	70,000	170,000
Required Interceptors	-		-	890,000	40,000	-	40,000
Independent Industrial Waste Correction				280,000	35,000	40,000	75,000
Total				2,590,000	175,000	110,000	285,000
Comparative Cost							
Primary Treatment All Waste				2,220,000	160,000	90,000	250,000
Sedondary Treatment All Waste				3,010,000	210,000	125,000	335,000
As Suggested				2,590,000	175,000	110,000	285,000

Description

Small tributaries of the Ohio River not considered in separate sections of this report drain a total of about 23,780 square miles (slightly less than 12 percent of the entire basin) in the six states which border the Ohio River. The area drained in each state and the drainage areas of some of the larger streams are shown below:

State	Area (Sq.Mi.)	State	Area (Sq.Mi.)
Illinois	2,880	Ohio	6,450
Indiana	3,480	Pennsylvania	1,290
Kentucky	6,675	West Virginia	3,005

Tributary	Right or Left Bank	Miles Above Mouth of Ohio River	Drainage Area (Square Miles)
Cache River	R	6.3	720
Tradewater River	L	107.6	995
Saline River	R	113.7	1,235
Blue River	R	318.1	466
Brush Creek	R	593.0	435
Little Sandy R.	L	644.6	780
Twelvepole Cr.	L	667.7	441
Raccoon Cr.	R	704.9	684
Middle Island Cr.	L	827.0	685
Little Beaver R.	R	941.5	510

Most of the area drained by the minor tributaries of the Ohio is hilly. Portions of the area in Illinois and Indiana are less rugged and better suited to agriculture than the land farther east.

The following tabulation of population of some of the larger communities and of the entire area, shows the relatively sparse population and the lack of urbanization. There are only 16 urban communities in the 23,780 square miles and most of these are in the upper part of the basin. The larger communities are in coal-producing sections.

Larger Cities	Population			
	1910	1920	1930	1940
Washington, Pa.	18,778	21,480	24,545	26,166
Canonsburg, Pa.	3,891	10,632	12,558	12,599
Salem, Ohio	8,943	10,305	10,622	12,301
Harrisburg, Ill.	5,309	7,125	11,625	11,453
Wellston, Ohio	6,875	6,687	5,319	5,537
E.Palestine, Ohio	3,537	5,750	5,215	5,123
Barnesville, Ohio	4,233	4,863	4,602	5,002
Entire Basin				
Urban	79,125	109,613	116,468	130,344
Rural	1,148,878	1,123,996	1,144,622	1,254,858
Total	1,228,003	1,233,609	1,261,090	1,385,202

Agriculture is the predominant occupation in the area as a whole but there are also important coal mining areas in Pennsylvania, the panhandle of West Virginia and adjacent parts of Ohio in the upper portion of the basin and in the Saline and Tradewater River basins in the lower portion of the basin.

Water Uses - None of the minor tributaries have been developed for navigation. There are no hydroelectric developments. Many of the streams, particularly the less polluted ones which are readily accessible to residents of the larger Ohio River cities, are used extensively for recreation.

Presentation of Field Data

Figures Oh-1, Oh-2 and Oh-3 show the location and magnitude of the more important sources of pollution along minor tributaries in the upper, middle and lower thirds of the Ohio River, respectively.

Public Water Supplies - Ninety-four communities and sizable institutions on minor tributaries of the Ohio have water supply systems which serve about 213,700 people. Forty-four of the supplies are from surface sources of which nine are from streams subject to sewage pollution above the water intake. The remaining 35 supplies are from streams draining unsewered areas. Table M-2 shows data on the nine surface water supplies which are most subject to pollution.

Table M-2 Minor Tributary Basins - Surface Water Supplies

Supply	State	Source	Mileage (1)	Mileage (2)	Treatment (3)	Population Served	Cons. M.G.D.
Supplies Below Community Sewer Outfalls							
Sturgis	Ky.	Tradewater River	7	108	LD	3.100	0.06
Providence	"	" "	41	108	FD	4,300	0.25
Harrisburg	Ill.	Mid.Fk. Saline R.	35	114	FD	8,000	0.53
Versailles	Ind.	Laughery Creek	34	482	FD	500	0.02
Osgood	"	" " - Wells	37	482	FD	1,000	0.08
Georgetown	Ohio	Whiteoak Creek	8	557	LD	1,500	0.04
Wellston	"	L.Raccoon Cr.-Imp.	55	705	FD	4,700	0.30
Middlebourne	W.Va.	Middle Island Cr.	37	827	FD	600	0.04
Bethany	"	Buffalo Creek	13	906	FD	900	0.07
Total - Below Sewer Outfalls						24,600	1.39
35 Other Surface Supplies						108,000	8.06
Total - Surface Water Supplies						132,600	9.45

(1) Miles above confluence of minor tributary with Ohio River.

(2) Miles from mouth of Ohio River to mouth of minor tributary.

(3) F - Coagulated, settled, filtered; L - Lime-soda softened; D - Chlorinated.

Sewerage - Table M-3 shows the sewered population and the total waste load at the larger sources of pollution on minor tributaries of the Ohio River. Sewage from 167,800 people enters the streams, about two-thirds of which is treated in 12 primary and 30 secondary treatment plants. Most of the larger sources of pollution are in the upper part of the area. Minor tributaries entering the Ohio above Huntington drain about one-third of the area but they receive about two-thirds of all the sewage.

Industrial Wastes - Relatively little organic industrial waste enters the minor tributaries. Table M-4 shows the industrial wastes to be equivalent in oxygen demand to sewage from 31,200 people, almost all of which comes from canneries and meat packing plants. Most of these are located on small streams in Indiana.

Acid Mine Drainage - Probably the most damaging pollution to which the minor tributaries of the Ohio are subjected is from acid mine drainage which affects streams in the upper part of the basin, particularly above Marietta, Ohio, and in the lower part of the basin where the Saline and Tradewater Rivers are the largest acid streams. The total acid load in the entire area before mine sealing is estimated at about 230,000 tons per year. Some 53,000 tons have been removed by sealing. More than 80 percent of the acid is from the area above Huntington. This problem is discussed in a section of the report on Acid Mine Drainage.

Table M-3 Minor Tributary Basins - Sources of Pollution Including Industrial Wastes Expressed as Sewered Population Equivalent (B.O.D.).

Municipality	State	Receiving Stream	Mileage		Population Connected to Sewers	Treatment	Sewered Population Equivalent (B.O.D.)	
			(1)	(2)			Untreated	Discharged
Mounds	Ill.	Trinity Slough	3	7	2,000	None	2,000	2,000
Providence	Ky.	Owens Creek	43	108	3,800	Chemical	3,800	1,900
Dawson Springs	"	Tradewater River	87	108	1,300	None	1,300	1,300
Harrisburg	Ill.	Penkey Branch	35	114	8,000	Secondary	8,000	1,200
Eldorado	"	Eldorado Ditch	39	114	3,000	None (3)	3,000	3,000
Morganfield	Ky.	Lost Creek	11	138	2,000	"	2,000	2,000
Fort Branch	Ind.	Pigeon Creek	44	188	100	"	11,100	11,100
Boonville	"	Cypress Creek	13	205	3,000	"	3,000	3,000
Marengo	"	Whiskey Run	27	318	100	"	9,800	9,800
Central Barren	"	Sinkhole	28	323	-	"	4,000	4,000
Sunman	"	N. Hogan Creek	22	484	-	"	3,600	3,600
Olive Hill	Ky.	Tygart Creek	52	628	1,000	"	1,000	1,000
Wellston	Ohio	Meadow Run	55	705	2,000	Primary	2,300	1,600
Caldwell	"	Duck Creek	39	810	1,000	None	1,000	1,000
West Union	W.Va.	Middle Island Cr.	71	827	1,000	"	1,000	1,000
Woodsfield	Ohio	Standing Stone Run	21	863	2,200	Primary	2,200	1,400
Cameron	W.Va.	Grave Creek	18	879	1,600	None	1,600	1,600
Avella	Pa.	Cross Creek	14	909	1,000	"	1,000	1,000
Salineville	Ohio	Riley Run	12	931	1,500	"	1,500	1,500
Lisbon	"	Middle Fk.L.Beaver	24	942	3,400	"	3,400	3,400
Salem	Ohio	" " " "	48	942	12,000	Secondary	12,000	1,800
Burgettstown	Pa.	Raccoon Creek	32	951	1,000	None	1,000	1,000
Oakdale	"	Robinson Run	15	978	1,600	"	1,600	1,600
McDonald	"	" "	18	978	3,100	"	3,100	3,100
Bridgeville	"	Chartiers Creek	9	978	4,200	"	4,200	4,200
Canonsburg	"	" "	25	978	13,000	"	13,000	13,000
Houston	"	" "	26	978	1,600	"	1,600	1,600
Washington	"	" "	35	978	28,000	Secondary	28,000	4,200
65 Smaller sources					65,300	(4)	67,900	24,000
Total - Illinois					20,900		20,900	8,300
Indiana					13,100		43,700	36,300
Kentucky					20,500		20,500	10,700
Ohio					47,300		47,800	17,000
Pennsylvania					58,200		58,200	30,900
West Virginia					7,800		7,900	7,700
Total - All minor tributaries					167,800		199,000	110,900

(1) Miles above confluence of minor tributary with Ohio River.
(2) " " mouth of Ohio River at mouth of minor tributary.
(3) Septic tank ineffective.
(4) Nine places, primary treatment; 28 places, secondary treatment; remaining 28 places, no treatment.

Table M-4 - Minor Tributary Basins - Summary of Industrial Wastes not Discharged to Municipal Treatment Plants with Total Industrial Waste Load in the Basin

Industry	Number of Plants	Industrial Waste Disposal		At Least Minor Corrective Measures Taken	Estimated Sewered Population Equivalent (B.O.D.)
		Munic. Sewers	Private Outlets		
Canning	6	-	6	5	13,300
Meat	7	-	7	7	16,700
Milk	2	-	2	1	300
Steel	4	-	4	2	-
Miscellaneous	5	1	4	1	-
Wastes Unconnected Munic. Treatment	24	1	23	16	30,300
Wastes Discharged to Municipal Treatment					900
Total - Industrial Waste Load - Minor Tributaries					31,200

Presentation of Laboratory Data

The maps which show coliform, dissolved oxygen and B.O.D. results on the main Ohio River also show similar data on its minor tributaries. Summaries of laboratory results are shown on Table M-7. Sampling of these areas was done concurrently with work on the adjacent sections of the Ohio River but was generally less intensive than on the main stream or the larger tributaries.

Pittsburgh to Huntington

In general, coliform counts were high along the minor tributaries in this section. A number of the streams were heavily acid. Acid data are summarized in Table M-7A. Oxygen conditions were generally rather good except on Chartiers Creek below Washington and Canonsburg, Pennsylvania, and on some of the very small tributaries.

Huntington to Cincinnati

None of the minor tributaries on this section were found to be heavily polluted although a number of them showed moderately high coliform counts below some of the small sources of pollution. Oxygen results were good, with B.O.D's. generally below three parts per million and dissolved oxygen over 6.5 parts per million.

Cincinnati to Louisville

The tributaries in this section also were found to be in generally good condition. Local pollution was evidenced on Laughery Creek at Batesville, Indiana, Hogan Creek at Aurora, Indiana, Harrods Creek at LaGrange, Kentucky, and Goose Creek at Anchorage, Kentucky.

Louisville to Mouth

This section includes the two largest of the Ohio River's minor tributaries, the Saline and Tradewater Rivers which enter the main stream about 110 miles above its mouth. Several of the tributaries of the Saline were found to be acid. Low dissolved oxygen, high B.O.D's. and high coliform counts were found below Eldorado and Harrisburg, Illinois. In the Tradewater basin local pollution was found at Dawson Springs, Sturgis and Providence, Kentucky, and acid was found at Earlington and Providence. Both the Tradewater and Saline were in good sanitary condition at their mouths during the sampling period. Acid results on these streams are summarized below:

Station	Month 1940	No. Samples	pH	Average Acidity P. P. M.			Average Iron p. p. m.	
				Methyl Red	Phenolphthalein			
					Hot	Cold	Ferrous	Total
Saline River								
Eldorado	Aug.	1	2.8	1,228	2,505	2,404	500	750
Wasson	Aug.	3	4.2	405	940	536	8*	50*
Harrisburg	Aug.	3	3.1	548	1,340	774	6**	145**
Pankey Fork	Aug.	3	4.3	103	445	202	12**	103**
Tradewater R.								
Earlington	Nov.	3	3.3	241	1,024	891	456	475
Providence	Oct.	1	3.6	98	169	157	2	12
"	Nov.	1	5.7	-	76	64	5	10

* One sample only. ** Average two samples only.

Other places where more or less heavy pollution was found were on Cypress Creek below Boonville, Indiana, Indian Creek below Corydon, Indiana, Beargrass Creek at Louisville, Kentucky, Lost Creek below Morganfield, Kentucky, and Crooked Creek below Marion, Kentucky.

Table M-5 - Minor Tributary Basins - Selected Laboratory Data

River Location	Chartiers Creek			M.Fk.Little Beaver below Salem, O.	M.Fk.Short Creek below Cadiz, O.	N.Fk.Cedar Cr. below Ky. State Prison	Goose Cr. below Anchorage, Ky.
	below Washington, Pa.	below Canonsburg, Pa.	above Carnegie, Pa.				
River Miles Above:							
Confluence with Ohio	34	23	8.5	37	25	9	4
Mouth of Ohio (1)	978	978	978	942	900	385	384
Period - 1940	Oct.	Oct.	Oct.	June-July	Oct.	July-Aug.	July-Aug.
Number of Samples	3	3	4	3	2	3	3
Flow in c.f.s.:							
Sampling Days	-	-	-	1	-	-	*
Minimum Month	-	-	24	-	-	-	-
Water Temperature °C.	14.7	14.3	11.0	21.5	10.0	27.8	24.2
Coliforms per ml.	4,800	587	6	102	5,960	9,510	114,000
Dissolved oxygen ppm.	0.5	1.6	5.3	5.8	5.4	1.9	0.0
B.O.D., 5-day p.p.m.	15.9	8.3	8.0	2.6	9.3	28.2	52.0

River Location	Beargrass Creek near Mouth	Indian Cr. below Corydon, Ind.	Cypress Cr.below Boonville Ind.	Lost Cr. below Morganfield, Ky.	Drainage Ditch bel. Eldorado, Ill.	Pankey Fk. below Harrisburg Ill.	Crooked Cr.below Marion, Ky.
River Miles Above:							
Conf. with Ohio	0.1	16	1	7	38	34	10
Mouth of Ohio	379	323	205	138	114	114	103
Period - 1940	Oct.	Aug.	Oct.	Oct.-Nov.	Aug.	Aug.	Oct.-Nov.
Number of Samples	2	3	3	3	3	3	3
Flow in c.f.s.:							
Sampling Days	-	-	-	1	1	1	*
Water Temperature °C.	17.5	26.5	14.8	13.7	32.5	26.2	16.2
Coliforms per ml.	46,000	23,800	11,200	4,730	15,600	16	3,000
Dissolved oxygen p.p.m	0.0	4.7	0.0	6.5	0.0	1.8	3.7
B.O.D., 5-day, p.p.m.	51.2	6.9	35.6	7.2	31.8	10.4	16.3

(1) Miles from mouth of Ohio to mouth of tributary.
* Less than one.

Hydrometric Data

Sixteen stream gaging stations have been maintained at various times on minor tributaries of the Ohio. Five of these stations are currently in operation. Table M-6 shows data on low summer flows at a few of the stations.

Table M-6 - Minor Tributary Basins - Monthly Mean Summer Flows for Years in which Low Summer Flows have Occurred.

River Location	Chartiers Creek Carnegie, Pa.	L.Beaver R. East Liverpool, Ohio	Middle Island Cr. Little, W.Va.	Raccoon Creek Adamsville, Ohio
River Miles Above:				
Conf.with Ohio	8	4	25	25
Mouth of Ohio(1)	978	942	827	705
Drain.Area Sq.Mi.	264	505	458	587
Period of Record	1919-33	1915-40	1915-20, 1925-40	1915-35, 1938-40
Year	1927	1932	1930	1930
June c.f.s.	325	76	11	29
July "	135	131	2	11
August "	62	26	0	14
September "	24	17	0	3
Year	1929	1930	1932	1922
June "	155	102	54	548
July "	96	30	255	72
August "	44	22	166	7
September "	26	28	2	152
Year	1932	1939	1936	1932
June "	60	359	5	57
July "	67	226	108	255
August "	30	103	34	25
September "	26	29	6	11

(1) Miles above mouth of Ohio at mouth of tributary stream.

A large part of the flow of Chartiers Creek is mine drainage. Other minor tributaries are subject to extremely low flows.

Proposed Flow Regulation - One of the reservoir sites studied by the U. S. Engineer Department for Ohio River flood control is located on Twelvepole Creek, a minor tributary which enters the Ohio River near Huntington, West Virginia. This is a relatively clean stream receiving a small amount of sewage from one rural community. Low-flow regulation by the proposed reservoir would have no appreciable tangible value for pollution abatement.

Discussion

Pollution problems on the minor tributaries of the Ohio are predominantly local in nature and are concerned primarily with prevention or correction of offensive conditions in small streams subject to extremely low flows. An exception to this is the acid problem which must be attacked on a more or less basin-wide scale, at least in the upper third of the Ohio Basin. None of the nine surface water supplies shown in Table M-2 is subject to heavy sewage pollution and although adequate bacteriological data are not available, it is probable that the water treatment plants are not overloaded. Several of the water supplies are affected by acid mine drainage notably the Harrisburg, Illinois, supply.

Recreational use of these minor tributaries is extensive, particularly in the neighborhood of the large Ohio River cities. The small tributaries are usually the cleanest streams for water sports and the rugged terrain through which most of them run is attractive for summer cottages. Even in the upper part of the basin where mine acid has damaged many of the streams there are some which are notable for their recreational value.

The low flows to which most of the streams are subject make rather complete treatment of wastes necessary for the prevention of local nuisance conditions. Each stream, however, presents more of an individual problem than is the case in the larger tributary basins where the effects of pollution may be felt more generally.

Most of the sewage is already being treated. Some of the existing plants appear to be inadequate. Estimated costs of a suggested program for abatement of sewage and industrial waste pollution are summarized in Table M-1. Reduction in the mine acid load is badly needed. The cost of work to accomplish this is shown in the section on Acid Mine Drainage.

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Chartiers Cr. At City Limits-Washington, Pa.	OCh 37	Oct. 7		16.0	8.2	85.4	1.3	46	6.8	5	108	
" "	" "	" 15		14.0	6.2	59.3	1.5	9	6.5	12	152	
" "	" "	" 23		7.0	9.5	77.7	0.6	2	6.6	12	161	
" "	" "	Nov. 12	15	8.5	9.3	79.1	1.2	46	6.9	21	127	
" "	" "	" 25	16	4.5	10.4	79.8	0.9	21	6.7	8	149	
" "	" "	Dec. 5	12	4.0	12.9	98.1	1.3	43	6.7	10	124	
" "	" "	" 17	12	3.5	11.5	86.2	0.5	23	6.9	20	98	
" "	" "	" 27		8.5	10.3	87.9	0.8	46	6.7	7	129	
Chartiers Cr. - .2 mi. Below Sew. Tr. Plant Washington, Pa.	OCh 34	Oct. 7		20.0	0.0	00.0	34.5	1,100	6.7	71	146	
" "	" "	" 15		15.0	1.5	14.8	6.2 42.2*	11,000	5.8	115	15	
" "	" "	" 23		9.0	0.0	00.0	6.9 24.6*	2,300	5.9	145	19	
" "	" "	Nov. 12	19	8.5	5.5	47.2	13.5	24,000	7.1	40	132	
" "	" "	" 25	24	4.5	6.7	51.6	9.1	9,300	6.8	26	135	
" "	" "	Dec. 5	22	3.0	9.9	73.4	7.6	2,300	6.7	90	92	
" "	" "	" 17	18	4.0	10.0	76.3	4.7	2,300	7.0	30	107	
" "	" "	Dec. 27		10.0	6.7	59.1	10.6	11,000	6.9	28	135	
Chartiers Creek - 0.1 Below Meadowlands, Pa.	OCh 29	Oct. 7		18.5	0.0	00.0	23.5	1,100	6.7	98	135	
" "	" "	" 15		14.0	0.0	00.0	40.6	110,000	6.6	90	138	
" "	" "	" 23		8.5	0.0	00.0	44.0	0	6.3	140	65	
" "	" "	Nov. 12	24	8.5	1.0	8.5	12.0	4,600	6.8	46	110	
" "	" "	" 25	41	5.5	1.9	15.4	21.7	2,300	6.8	38	138	
" "	" "	Dec. 5	27	3.0	8.6	63.8	16.3	2,300	6.5	100	16	
" "	" "	" 17	32	3.5	8.0	60.4	6.2	2,300	7.1	40	110	
" "	" "	" 27		10.0	2.4	21.3	12.9	4,600	6.7	35	110	
Chartiers Creek-Below Houston, Pennsylvania	OCh 26	Oct. 7		16.0	2.5	25.9	3.5 4.4*	39	5.6	88	7	
" "	" "	" 15		13.5	0.0	00.0	11.0	93	6.0	93	7	
" "	" "	" 23		8.0	5.1	43.1	6.6	240	6.5	22	71	
" "	" "	Nov. 12	36	7.5	3.6	29.9	5.0	93	6.6	68	49	
" "	" "	" 25	58	5.0	6.9	53.8	3.1	1,100	6.8	33	91	
" "	" "	Dec. 5	38	1.0	10.9	76.6	5.4	430	6.7	45	92	
" "	" "	" 17	40	4.0	8.8	67.0	5.8	2,400	7.1	30	99	
" "	" "	" 27		9.0	7.0	60.4	5.7	2,400	6.9	18	118	
Chartiers Creek-½ mile Below Cannonsburg, Pa.	OCh 23	Oct. 7		19.0	[illegible]	25.6	5.0 17.8*	1,100	4.0	23		
" "	" "	" 15		15.0	2.0	19.8	7.0 20.5*	230	3.3	28		
" "	" "	" 23		9.0	0.3	2.4	12.9	430	6.0	32	11	
" "	" "	Nov. 12	42	9.5	2.8	24.1	5.6	230	6.4	34	6	
" "	" "	" 25	73	6.0	7.5	59.9	11.4	23	6.2	22	8	
" "	" "	Dec. 5	44	1.0	12.3	86.5	5.8	460	6.8	70	80	
" "	" "	" 17	51	4.0	10.5	79.8	5.6	4,600	7.2	30	98	
" "	" "	" 27		9.0	9.3	80.4	5.9	11,000	7.0	23	122	
Chartiers Creek-1 mile Below Morganza, Pa.	OCh 21	Oct. 7		18.0	0.9	9.4	4.1	460	6.6	90	36	
" "	" "	" 15		13.0	2.4	23.1	7.1 15.2*	4,600	5.5	108	5	
" "	" "	" 23		8.5	1.6	13.6	15.6	910	6.1	115	13	

TABLE K-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940		Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
							p.p.m.	% Sat.						
Chartiers Creek - 1 mi. below Morganza, Pa.	OCh	21	Nov.	12	42	7.0	5.0	40.7	3.0	91	6.4	68	23	
" "	"	"	"	25	75	4.5	7.2	55.6	7.1	93	6.2	35	8	
" "	"	"	Dec.	5	45	1.0	12.1	84.9	7.3	93	6.7	70	56	
" "	"	"	"	17	52	4.5	9.8	75.7	3.4	240	7.0	40	63	
" "	"	"	"	27		9.0	9.1	78.2	5.5	240	7.1	23	136	
Miller Run-½ mile above Cecil, Pennsylvania	OChM	16.5	Oct.	1		13.0	10.9	103.0	6.4	**	3.1	13		
" "	"	"	"	8		12.0	8.7	80.0	7.1	0	3.0	16		
" "	"	"	"	17		4.0	12.4	94.2	6.4 0.[illegible]*	0	2.8	38		
" "	"	"	"	24		10.0	9.4	83.4	6.5 2.8*	0	3.0	49		
" "	"	"	Nov.	5		9.5	10.1	88.3	7.2 2.0*	0	4.5	79	15	
" "	"	"	"	18	2	1.0	12.5	87.7	6.3 2.8*	0	4.5	120	8	
" "	"	"	"	29	9	2.0	12.4	89.7	0.8	11	6.4	60	34	
" "	"	"	Dec.	11	4	3.0	12.6	93.3	0.9	110	6.3	55	100	
" "	"	"	"	23	2	4.5	10.6	81.5	1.7 1.2*	9	5.6	150	12	
Miller Run- ¾ mi.below Cecil, Pennsylvania	OChM	15.5	Oct.	1		13.0	9.4	88.7	7.3 1.7*	0	3.0	6		
" "	"	"	"	8		12.5	9.1	84.8	7.0 0.9*	0	3.0	18		
" "	"	"	"	17		3.5	11.7	88.2	7.4 1.4*	0	2.8	12		
" "	"	"	"	24		10.0	9.2	80.9	6.5 2.6*	0	3.1	15		
" "	"	"	Nov.	5		9.0	9.8	84.6	0.9 2.0*	11	5.3	94	8	
" "	"	"	"	18	3	0.0	12.2	83.5	6.3 2.4*	0	5.0	110	11	
" "	"	"	"	29	13	2.0	12.8	92.3	0.8	11	6.6	55	99	
" "	"	"	Dec.	11	8	3.0	12.4	92.4	0.8	110	6.8	80	99	
" "	"	"	"	23	2	4.0	10.0	76.2	1.4 0.8*	23	5.4	220	24	
Robinson Run - above Midway, Pennsylvania	OChR	22.5	Oct.	2		12.0	8.1	74.4	1.6	110	7.4	45	237	
" "	"	"	"	10		6.0	7.1	57.2	1.2	93	7.0	8	259	
" "	"	"	"	21		5.0	8.0	62.1	0.1	150	6.6	6	244	
" "	"	"	"	28		8.0	9.2	77.9	7.6	1,100	6.8	12	236	
" "	"	"	Nov.	7	**	5.0	10.6	82.8	1.0	43	6.8	18	220	
" "	"	"	"	20	**	4.5	10.3	79.1	0.5	460	6.5	10	231	
" "	"	"	Dec.	3	**	0.0	12.6	85.9	0.6	15	6.8	15	203	
" "	"	"	"	13	**	6.0	10.9	87.2	0.9	23	6.8	35	169	
Robinson Run- Below Midway, Pennsylvania	OChR	21.5	Oct.	2		11.0	9.8	88.2	0.9 1.2*	**	3.2	28		
" "	"	"	"	10		6.5	10.5	84.9	0.7 1.7*	**	3.1	31		
" "	"	"	"	21		5.5	11.1	87.9	1.5 2.2*	1	2.9	42		
" "	"	"	"	28		8.0	10.6	89.0	1.7 0.9*	1	3.2	36		
" "	"	"	Nov.	7	1	5.0	11.5	89.7	1.0 1.0*	**	4.5	39	5	
" "	"	"	"	20	1	4.5	12.2	94.2	1.0 1.8*	**	4.4	40	8	
" "	"	"	Dec.	3	2	1.5	13.0	92.4	0.8 1.4*	**	4.6	85	5	
" "	"	"	"	13	1	5.5	11.1	88.1	0.6	24	6.1	50	23	
Robinson Run-½ mi.Above McDonald, Pa.	OChR	19	Oct.	2		12.0	10.4	96.4	7.5 1.1*	0	2.9	37		
" "	"	"	"	10		6.5	8.4	76.3	7.5 1.2*	0	2.8	32		
" "	"	"	"	21		5.0	9.5	74.3	7.6 0.4*	0	2.4	24		
" "	"	"	"	28		7.5	10.4	86.6	7.5 2.3*	0	2.8	17		

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940		Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Robinson Run - ½ mile Above McDonald, Pa.	OChR	19	Nov.	7	2	4.5	11.5	88.5	6.8 1.4*	**	3.5	87		
" "	"	"	"	20	2	5.0	11.8	91.9	8.1 1.9*	**	3.3	90		
" "	"	"	Dec.	3	4	1.0	14.6	102.4	6.9 1.8*	**	4.0	170		
" "	"	"	"	13	2	6.5	11.3	91.5	3.0 1.2*	**	4.5	100	6	
Robinson Run - ½ mile Below McDonald, Pa.	OChR	17.5	Oct.	2		14.0	8.2	78.9	7.1 7.3*	**	3.1	152		
" "	"	"	"	10		6.5	10.0	81.2	7.8 2.7*	**	[illegible]	138		
" "	"	"	"	21		5.5	10.3	81.2	7.0 6.1*	1	2.4	205		
" "	"	"	"	28		9.0	11.0	94.9	5.7 7.3*	**	[illegible]	195		
" "	"	"	Nov.	7	2	4.0	11.0	84.0	6.4 3.0*	4	4.2	70		
" "	"	"	"	20	2	5.0	12.0	93.7	9.0 4.4*	110	3.7	75		
" "	"	"	Dec.	3	5	0.0	14.1	96.3	7.4 4.1*	4	4.3	150	5	
" "	"	"	"	13	3	7.0	10.8	68.7	4.5 2.5*	9	4.5	110	8	
N.Fk.Robinson Run-½ mi. Above Oakdale, Pa.	OChRNf	15.5	Oct.	1		11.5	10.7	97.8	1.0 1.4*	0	2.8	4		
" "	"	"	"	8		12.5	7.2	66.8	1.8 1.4*	0	2.9	4		
" "	"	"	Oct.	17		4.0	12.0	91.6	1.3 1.3*	0	2.6	4		
" "	"	"	"	24		10.0	10.2	89.8	0.9 1.7*	0	2.9	4		
" "	"	"	Nov.	5		9.5	10.8	93.9	1.5 1.2*	0	3.3	11		
" "	"	"	"	18	3	0.5	11.9	82.5	1.9 0.6*	**	3.3	95		
" "	"	"	"	29	17	4.0	12.9	98.5	1.7 0.8*	11	3.2	85		
" "	"	"	Dec.	11	6	3.0	12.8	95.1	1.0 1.1*	0	2.8	85		
" "	"	"	"	23	3	4.5	12.2	94.0	0.9 1.2*	0	2.9	60		
Robinson Run-upper limits Oakdale, Pa.	OChR	15.5	Oct.	1		12.0	10.3	95.3	7.9 2.4*	0	2.9	19		
" "	"	"	"	8		11.0	9.0	81.3	6.9	0	3.0	17		
" "	"	"	"	17		4.0	9.0	68.5	7.8 6.0*	0	2.8	24		
" "	"	"	"	24		10.0	7.6	66.8	6.3 3.7*	0	3.1	52		
" "	"	"	Nov.	5		10.5	10.1	90.0	8.3 5.4*	2	3.8	48		
" "	"	"	"	18	4	0.5	12.3	85.0	7.9 5.0*	24	3.7	110		
" "	"	"	"	29	24	3.5	12.9	97.3	4.9 2.0*	0	4.4	85	9	
" "	"	"	Dec.	11	8	3.0	12.4	92.0	6.6 2.9*	**	3.8	130		
" "	"	"	Dec.	23	4	3.5	12.2	91.9	6.2 2.3*	5	3.8	120		
Robinson Run - ¾ mile Below Oakdale, Pa.	OChR	14.5	Oct.	1		12.0	9.5	87.3	5.7 2.2*	0	2.8	17		
" "	"	"	"	8		11.5	6.9	62.7	3.3*	0	3.0	8		
" "	"	"	"	17		3.5	10.2	76.8	4.3 3.0*	0	2.7	11		
" "	"	"	"	24		10.0	7.7	68.2	4.8 3.0*	0	3.1	14		
" "	"	"	Nov.	5		10.5	10.1	89.9	6.2 4.6*	2	3.5	32		
" "	"	"	"	18	8	0.0	13.3	91.0	5.3 2.7*	4	3.5	75		
" "	"	"	"	29	42	1.5	14.0	99.9	3.3 1.4*	1	3.9	85		
" "	"	"	Dec.	11	14	2.5	12.9	94.6	4.3 2.3*	1,100	3.1	90		
" "	"	"	"	23	7	4.0	12.5	95.3	3.4 2.1*	0	3.0	110		
Chartiers Creek-Above Carnegie, Pa.	OCh	6.5	Oct.	1		14.0	7.0	67.3	8.8 8.0*	14	3.9	25		
" "	"	"	"	8		13.5	4.2	40.2	8.4 3.7*	9	3.4	17		
" "	"	"	"	17		5.5	6.0	47.6	7.2 13.1*	2	3.4	14		
" "	"	"	"	24		11.0	4.1	36.9	7.5 22.4*	0	3.4	11		

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Chartiers Creek - Above Carnegie, Pennsylvania	OCh 8.5	Nov. 5		11.0	8.1	73.3	7.3 18.5*	11	5.3	90	11	
" "	" "	" 18	78	2.0	10.7	77.1	5.3 7.0*	2	5.1	95	8	
" "	" "	" 29	134	1.5	11..	83.5	2.9	110	6.3	125	12	
" "	" "	Dec. 11	93	3.5	11.0	83.0	2.6	23	6.0	95	30	
" "	" "	" 23	81	4.5	10.3	79.4	3.5	93	6.1	120	52	
Chartiers Creek - Below Carnegie, Pennsylvania	OCh 6.5	Oct. 1		14.5	6.2	60.5	7.8 7.9*	6	3.2	35		
" "	" "	" 8		15.0	6.2	60.9	0.5 3.8*	46	4.0	34		
" "	" "	" 17		7.5	6.9	57.2	7.0 21.9*	14	3.3	28		
" "	" "	" 24		12.0	5.6	51.7	7.3 17.8*	4	3.5	64		
" "	" "	Nov. 5		11.0	8.2	74.5	8.3 18.9*	9	5.0	71	7	
" "	" "	" 18	86	2.0	9.3	67.5	8.0 20.2*	110	5.2	130	12	
" "	" "	" 29	178	2.0	11.6	83.6	3.8	23	6.1	90	8	
" "	" "	Dec. 11	112	4.0	11.3	86.0	5.4	240	6.0	90	24	
" "	" "	" 23	90	5.0	10.8	84.1	6.3 8.6*	4	5.4	110	11	
Raccoon Creek-½ mi.Above Burgettstown, Pa.	ORa 32.5	Oct. 2		13.0	9.1	85.7	6.4 2.1*	0	2.9	88		
" "	" "	" 10		10.0	9.0	79.4	6.8 4.8*	0	2.8	63		
" "	" "	" 21		9.5	9.2	80.3	7.0 2.8*	0	2.5	162		
" "	" -	" 28		12.0	11.5	106.3	6.4 3.5*	0	2.9	112		
" "	" "	Nov. 7	5	7.0	10.9	89.2	4.2 2.6*	2	3.9	108		
" "	" "	" 20	4	7.5	10.5	87.2	7.5 1.8*	1	3.4	170		
" "	" "	Dec. 3	13	1.0	12.4	87.4	7.2 2.8*	0	4.5	230	8	
" "	" "	" 13	5	6.0	10.4	83.6	3.0 1.5*	2	5.6	130	32	
Raccoon Cr.- ½ mi.below Burgettstown, Pa.	ORa 31.5	Oct. 2		11.5	10.2	92.7	6.5 2.8*	**	2.9	33		
" "	" "	" 10		8.0	7.7	64.9	7.5 4.0*	0	2.5	4		
" "	" "	" 21		6.5	9.7	78.4	8.0 2.0*	0	2.5	45		
" "	" "	" 28		9.0	9.6	82.7	7.4 3.7*	0	2.9	30		
" "	" "	Nov. 7	7	5.5	11.3	87.6	7.5 3.2*	8	3.4	148		
" "	" "	" 20	6	5.5	11.1	88.1	7.9 3.0*	1	3.3	120		
" "	" "	Dec. 3	17	0.0	13.3	90.8	7.7 4.0*	2	4.3	200	6	
" "	" "	Dec. 13	10	6.5	11.7	94.7	7.7 1.6*	0	4.2	180		
Raccoon Creek - At Mouth	ORa 0.5	Nov. 7		7.0	11.2	91.6	1.7 2.0*	**	4.9	3	5	
" "	" "	" 15	57	4.0	12.0	91.2	0.6	**	6.1	6	5	
" "	" "	" 25	59	5.5	11.1	88.0	2.8 3.2*	**	4.9	6	1	
" "	" "	Dec. 11		3.0	12.6	93.6	0.8 1.3*	2	5.9	23	11	
" "	" "	" 17	71	5.0	12.0	93.9	0.7	**	6.7	22	8	
" "	" "	" 23	65	3.5	12.0	90.3	0.7 2.2*	**	5.8	22	7	
Middle Fk.Little Beaver 1 mi. above Salem, Ohio	OLbMf 37	June 28	**	18.5	9.5	100.5	1.9	43	8.0	13	135	
" "	" "	July 10	**	22.0	5.4	62.7	2.9	23	7.5			
" "	" "	" 29	2	24.0	2.6	30.2	3.1	240	6.8			
Middle Fk.L.Beaver R. ¼ mi.below Salem, Ohio	OLbMf 32	June 28	5	19.0	5.6	60.3	4.7	91	7.4		132	140
" "	" "	July 10	3	21.5	5.9	66.2	2.0	25	7.6	7		202
" "	" "	" 29	32	25.0	4.1	49.0	12.7	240	7.6	15		172

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Middle Fk. Little Beaver 1 mi. above Leetonia, O.	OLbMf 35.5	June 26	1	13.5	8.9	85.2	6.4	460	7.1		64	
" "	" "	" 28	1	18.5	8.8	92.8	0.6	23	7.4			
" "	" "	July 10	1	20.5	6.0	66.2	0.9	2	7.2			
Middle Fk. Little Beaver 1 mi. below Leetonia, O.	OLbMf 33.5	June 26	3	17.0	6.3	64.4	2.2	73	7.6		107	
" "	" "	" 28	4	19.5	6.4	68.8	2.6	91	7.4	20		194
" "	" "	July 10	2	21.0	5.3	59.3	0.8	91	7.4	18		214
Middle Fk. Little Beaver ½ mi. above Lisbon, Ohio	OLbMf 25	June 26	38	16.5	8.7	88.6	1.2	9	7.3		109	
" "	" "	Sept. 26		11.5	9.5	86.5	1.5	43	7.0	8	120	
" "	" "	Oct. 3		12.0	9.2	84.9	1.0	4	7.0	8	128	
" "	" "	" 22		3.0	11.0	81.4	0.6	2	6.3	9	131	
" "	" "	" 31		6.0	9.6	77.1	1.7	11	7.3	9	147	
" "	" "	Nov. 8	22	4.5	11.3	87.3	1.1	46	6.8	6	107	
" "	" "	" 22	20	10.0	11.1	97.7	0.8	93	6.6	5	115	
" "	" "	Dec. 4	37	0.0	13.5	92.1	1.5	430	6.6	5	80	
" "	" "	" 16	25	5.0	12.6	98.6	1.2	430	6.6	30	64	
" "	" "	" 26		4.5	12.7	97.6	1.3	230	6.7	5	84	
Middle Fk. Little Beaver 2 mi. below Lisbon, Ohio	OLbMf 22	June 26	60	19.0	8.1	86.4	1.8	2,400	7.9	10	103	188
" "	" "	Sept. 26		11.0	8.8	79.1	2.1	460	7.2	11	121	
" "	" "	Oct. 3		12.5	6.9	64.7	2.9	91	7.1	12	131	
" "	" "	" 22		3.0	9.1	67.4	4.6	930	6.3	18	136	
" "	" "	" 31		7.5	9.2	76.9	2.1	430	7.1	8	137	
" "	" "	Nov. 8	23	4.0	10.8	82.5	2.2	240	7.0	9	113	
" "	" "	" 22	21	9.0	10.7	92.6	1.3	460	6.8	8	116	
" "	" "	Dec. 4	38	1.5	13.6	97.1	1.8	230	6.6	5	77	
" "	" "	" 16	26	5.0	12.0	93.8	3.5	930	6.7	45	54	
" "	" "	" 26		3.5	12.4	93.2	2.4	430	6.8	11	83	
Leslie Run-1 mi. above East Palestine, Ohio	OLbL 17.5	June 26	1	19.0	8.8	93.6	2.8	4	8.3		90	
Leslie Run-2 mi. below East Palestine, Ohio	OLbL 14.5	" 26	7	16.5	9.4	95.9	2.8	430	7.9	5	127	180
Little Beaver River At Mouth	OLL 0.2	Sept. 26		13.5	10.3	98.0	1.3	43	7.0	16	96	
" "	" "	" 30		[illegible]	9.5	92.7	1.0	4	6.7	15	50	
" "	" "	Oct. 2		15.0	9.7	95.6	0.6	**	6.5	5	46	
" "	" "	" 4		15.5	9.6	95.7	0.6	**	6.4	8	58	
" "	" "	" 8		16.0	9.2	92.4	1.1	5	6.6	9	50	
" "	" "	" 10		13.5	10.0	95.2	1.0	2	6.4	10	58	
" "	" "	" 14		13.5	9.6	91.3	0.9	46	6.4	9	54	
" "	" "	Oct. 16		13.0	9.8	92.1	1.2	46	6.4	8	45	
" "	" "	" 18		12.5	10.2	95.2	1.1	9	6.2	7	45	
" "	" "	" 22		9.0	11.1	95.9	1.1	9	6.0	8	67	
" "	" "	" 24		12.0	10.4	96.2	1.1	9	6.4	7	52	
" "	" "	" 28		11.5	10.4	94.9	1.0	9	6.3	8	44	
" "	" "	" 30		11.5	10.3	94.1	0.7	4	7.1	6	58	
" "	" "	Nov. 1		10.5	10.8	95.9	1.2	9	7.1	6	79	
" "	" "	" 5		9.5	10.9	95.4	2.0	9	6.4	8	107	

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
Little Beaver River At Mouth	OLb	0.2	" 7		6.0	11.7	93.8	0.8	2	6.9	5	94	
" "	"	"	" 13		5.0	12.3	96.2	1.1	24	7.0	15	85	
" "	"	"	" 15		3.5	12.7	95.3	0.8	2	6.9	7	84	
" "	"	"	" 19		1.0	14.1	99.3	1.0	**	6.5	10	84	
" "	"	"	" 25		5.0	12.6	98.2	0.9	1	6.8	6	93	
" "	"	"	" 27		2.0	13.0	94.1	2.5	110	6.8	85	67	
" "	"	"	" 29		0.5	14.0	96.9	1.5	36	6.5	18	54	
" "	"	"	Dec. 5		0.5	14.1	97.7	1.1	9	6.8	22	61	
" "	"	"	" 9		0.5	14.3	99.0	1.0	110	6.4	5	69	
" "	"	"	" 11		2.0	13.6	98.3	1.0	9	6.5	7	63	
" "	"	"	" 13		4.5	12.4	95.6	1.2	2	6.6	23	61	
" "	"	"	" 17		4.0	12.5	95.0	2.6	11	7.0	130	41	
" "	"	"	" 19		1.0	13.8	97.0	0.8	9	6.6	17	39	
" "	"	"	" 23		3.0	13.2	97.5	0.9	43	6.5	12	60	
" "	"	"	" 31		3.5	12.8	96.0	1.1	46	6.9	60	24	
" "	"	"	Jan. 2		4.5	12.5	96.5	0.7	9	6.8	18	33	
Yellow Creek-½ mile Above Amsterdam, Ohio	OY	25	Oct. 22		2.5	12.1	88.8	0.9	9	6.4	7	97	
" "	"	"	" 31		6.5	10.6	86.2	2.0	11	7.2	8	69	
" "	"	"	Nov. 8	2	2.5	13.0	95.4	1.0	460	7.1	8	73	
" "	"	"	" 22	2	11.0	11.4	103.1	0.8	39	7.1	10	69	
" "	"	"	Dec. 4	6	2.0	14.0	101.5	0.7	46	6.8	5	54	
" "	"	"	" 16	3	8.0	11.6	97.6	1.4	43	6.8	130	35	
" "	"	"	" 26		5.5	12.3	97.1	0.8	23	6.8	15	45	
Yellow Creek - 1 mile Below Amsterdam, Ohio	OY	23.5	Oct. 22		4	12.4	94.2	1.2	93	6.3	6	60	
" "	"	"	" 31		6.5	10.7	87.1	1.1	240	7.3	8	59	
" "	"	"	Nov. 8	3	3.0	12.6	93.3	0.9	4	6.8	10	48	
" "	"	"	" 22	3	11.5	11.1	101.5	0.8	24	7.0	5	59	
" "	"	"	Dec. 4	7	2.0	13.6	98.1	1.0	23	6.7	6	45	
" "	"	"	" 16	4	8.0	11.8	49.2	1.7	75	6.8	130	36	
" "	"	"	" 26		5.0	11.9	93.1	0.7	240	6.9	28	38	
Riley Run - ¾ mi.Above Salineville, Ohio	OYR	13	Sept. 26		10.0	11.2	98.4	0.8	93	7.3	8	30	
" "	"	"	Oct. 3		12.0	9.8	90.3	0.7	9	7.0	7	14	
" "	"	"	" 22		1.5	12.0	85.4	1.2	15	6.3	22	10	
" "	"	"	" 31		5.0	11.1	87.0	1.5	4	7.3	6	39	
" "	"	"	Nov. 8	1	2.5	12.8	93.7	0.7	24	7.1	7	36	
" "	"	"	" 22	1	10.5	11.2	99.6	0.5	24	6.9	6	38	
" "	"	"	Dec. 4	2	2.0	13.7	99.2	0.8	4	6.8	6	30	
" "	"	"	" 16	2	7.0	11.7	96.3	2.0	24	6.8	210	18	
" "	"	"	" 26		5.0	12.4	96.9	0.8	93	6.9	6	20	
Riley Run - ¾ mi.below Salineville, Ohio	OYR	11.5	Sept. 26		10.5	11.4	101.7	1.1	240	7.2	3	41	
" "	"	"	Oct. 3		12.5	9.6	89.8	1.3	28	7.0	trace	47	
" "		"	" 22		2.0	11.8	84.9	1.5	93	6.2	4	43	
" "	"	"	" 31		6.0	11.0	87.8	0.8	460	7.2	3	46	
" "	"	"	Nov. 8	3	3.0	12.4	91.8	0.5	23	6.9	3	45	
" "	"	"	" 22	3	11.5	11.0	100.5	0.7	43	6.9	3	23	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Riley Run - ½ mi. below Salineville, Ohio	OYR 11.5	Dec. 4	5	3.0	13.7	101.7	0.6	23	6.8	6	36	
" "	" "	" 16	5	7.0	11.7	96.4	2.5	460	6.7	110	20	
" "	" "	" 26		5.0	12.2	95.4	1.1	230	6.6	12	23	
N.Fk.Yellow Creek Above Irondale, Ohio	OYNf 5	Sept. 26		12.0	11.0	101.4	1.2	24	7.2	3	67	
" "	" "	Oct. 3		13.5	9.3	89.0	0.9	2	7.0	2	55	
" "	" "	" 22		7.0	11.8	96.6	0.7	1	6.4	4	57	
" "	" "	" 31		8.5	10.9	92.6	1.1	2	7.3	4	69	
" "	" "	Nov. 8	5	3.0	12.4	92.1	0.7	**	6.9	4	51	
" "	" "	" 22	5	12.0	11.6	107.5	0.5	2	6.9	4	35	
" "	" "	Dec. 4	8	3.0	14.0	104.0	0.8	11	6.8	7	38	
" "	" "	" 16	7	9.0	11.9	103.0	1.6	24	6.9	85	26	
" "	" "	" 26		6.0	12.4	99.4	0.6	15	6.9	6	34	
N.Fk.Yellow Creek-¾ mi. Below Irondale, Ohio	OYNf 3.5	Sept. 26		12.5	11.4	106.7	1.1	46	7.2	3	61	
" "	" "	Oct. 3		13.5	10.3	98.6	0.8	24	7.0	trace	60	
" "	" "	Oct. 22		7.5	12.4	103.1	0.7	39	6.4	3	60	
" "	" "	" 31		9.0	11.5	99.3	0.7	93	7.1	3	68	
" "	" "	Nov. 8	5	3.5	12.7	95.7	0.8	46	6.8	118	51	
" "	" "	" 22	5	12.0	11.4	105.6	0.9	9	6.9	5	51	
" "	" "	Dec. 4	8	2.5	13.9	101.5	0.8	9	6.8	7	33	
" "	" "	" 16	8	8.0	11.9	100.2	1.5	150	6.9	90	25	
" "	" "	" 26		6.0	12.3	98.8	0.7	9	6.9	5	30	
Yellow Creek At Mouth	OY 0.2	Nov. 14	30	4.0	12.7	96.8	0.5	24	6.6	9	59	
" "	" "	" 27	153	3.0	12.6	93.3	2.9	150	7.1	210	46	
" "	" "	Dec. 9	72	1.5	13.8	98.5	0.6	4	7.0	7	46	
" "	" "	" 19	36	1.0	13.5	95.0	0.4	9	7.1	12	36	
" "	" "	Jan. 2	359	6.0	12.2	97.9	0.6	9	6.9	23	25	
Harmon Creek - Mouth W. Va. Route #2	OH 0.2	Nov. 12	56	19.0	7.6	80.8	6.7 22.1*	0	2.7	19		
" "	" "	" 18	50	18.5	9.2	97.4	10.4 19.6*	**	2.7	15		
" "	" "	" 26	61	15.0	7.7	76.0	7.7 6.4*	43	2.9	12		
" "	" "	Dec. 2	55	12.0	9.4	86.4	8.2 32.4*	24	2.8	55		
" "	" "	" 10	65	15.0	8.9	87.7	7.2 16.7*	15	2.8	40		
" "	" "	" 18	48	12.0	9.9	91.1	6.1 12.0*	9	2.8	60		
" "	" "	" 26	70	15.0	8.7	85.4	4.0 19.1*	**	2.1	13		
Cross Creek - Mouth Ohio Route #7	OCr 0.2	Nov. 14	38	4.0	13.0	99.2	0.7	9	6.7	9	95	
" "	" "	" 27	134	3.0	12.4	92.4	2.6	240	7.0	170	54	
" "	" "	Dec. 9	50	1.0	13.9	97.9	0.5	9	6.8	23	79	
" "	" "	" 19	37	1.0	13.9	97.4	0.4	4	7.1	28	69	
" "	" "	Jan. 2	205	6.0	12.2	98.0	0.5	2	6.6	60	43	
Cross Creek - Mouth W. Va. Route #2	OCr 0.2	Nov. 12	16	9.0	11.6	100.1	1.6	110	7.0	53	113	
" "	" "	" 18	17	2.0	12.4	89.7	1.0	240	6.7	35	88	
" "	" "	" 26	16	2.0	13.4	96.6	1.7	0	7.0	30	101	
" "	" "	Dec. 2	20	2.5	13.5	98.9	2.0	43	6.8	60	97	
" "	" "	" 10	24	4.0	12.6	97.6	1.7	1,100	6.6	45	99	
" "	" "	" 18	17	4.0	13.0	98.7	0.9	23	6.8	40	98	
" "	" "	" 26	26	6.0	12.4	99.5	0.8	93	6.8	35	105	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
Buffalo Creek - Mouth 0.8 - W. Va. Route #67	OBu	0.8	Nov. 14	37	6.0	12.5	100.1	0.6	4	7.0	9	141	
" "	"	"	" 22	36	10.0	11.4	100.9	0.7	9	6.9	10	135	
" "	"	"	Nov. 28	160	2.0	13.2	95.2	1.3	5	6.9	55	88	
" "	"	"	Dec. 6	45	0.0	14.2	96.9	0.7	4	6.9	22	40	
" "	"	"	" 12	70	5.0	12.8	99.6	0.7	15	6.8	12	124	
" "	"	"	" 20		4.5	13.0	100.3	0.6	7	7.1	7	126	
" "	"	"	" 24		2.0	13.7	99.2	0.8	8	7.1	5	131	
Middle Fork Short Creek Below Cadiz, Ohio	OShMf	25.3	Sept. 27		10.0	10.4	91.9	1.8	1,100	7.1	5	157	
" "	"	"	Oct. 9		10.0	3.3	28.9	15.4	11,000	6.9	20	198	
" "	"	"	" 25		10.0	7.6	66.7	3.2	910	7.3	5	193	
" "	"	"	Nov. 1		9.5	7.8	68.0	4.4	4,600	6.9	8	183	
" "	"	"	" 6	2	7.0	10.3	84.5	2.7	2,300	6.8	13	168	
" "	"	"	" 19	2	0.0	11.3	77.3	1.5	930	6.7	10	160	
" "	"	"	Dec. 2	6	0.0	13.3	90.8	1.2	150	6.8	6	140	
" "	"	"	" 12	4	4.5	12.0	92.6	1.0	43	6.8	7	136	
" "	"	"	" 24	2	0.0	13.9	95.1	1.5	240	6.9	7	148	
Short Creek-upper limits Adena, Ohio	OSh	17.3	Sept. 27		10.0	12.6	111.0	0.8	240	7.2	5	116	
" "	"	"	Oct. 9		9.5	11.6	101.0	0.9	23	7.0	3	129	
" "	"	"	" 25		9.0	9.7	84.0	1.0	93	6.7	2	126	
" "	"	"	Nov. 1		9.0	10.1	87.2	0.8	15	6.9	4	128	
" "	"	"	" 6	40	7.5	11.2	93.3	1.0	150	6.9	21	119	
" "	"	"	" 19	35	0.0	14.4	98.5	0.6	46	6.9	15	153	
" "	"	"	Dec. 2	86	0.0	14.0	95.4	0.9	43	7.1	6	135	
" "	"	"	" 12	90	4.5	12.4	96.0	0.8	43	6.9	30	128	
" "	"	"	" 24	85	0.0	14.6	99.9	0.6	23	7.0	5	143	
Short Creek-½ mile Below Adena, Ohio	OSh	16.3	Sept. 27		10.0	10.5	92.5	1.4	240	7.0	25	69	
" "	"	"	Oct. 9		9.5	11.4	99.4	0.7	460	6.8	10	60	
" "	"	"	" 25		10.0	9.7	85.5	1.3	430	6.7	10	66	
" "	"	"	Nov. 1		9.0	10.5	90.4	1.1	36	6.8	8	85	
" "	"	"	" 6	40	7.5	11.1	92.6	1.0	460	6.8	50	75	
" "	"	"	" 19	36	0.0	13.9	95.2	0.9	460	6.8	35	112	
" "	"	"	Dec. 2	88	0.0	13.6	92.7	0.9	460	7.1	50	97	
" "	"	"	" 12	93	4.5	12.2	93.7	0.6	23	6.8	50	93	
" "	"	"	" 24	88	0.0	13.4	91.8	0.8	460	6.9	40	102	
Short Creek-½ mi.above Dillonvale, Ohio	OSh	10	Nov. 13	40	4.0	6.8	51.8	0.2	9	6.3	125	22	
" "	"	"	" 26	50	2.0	9.0	65.3	0.7	150	6.7	120	13	
" "	"	"	Dec. 6	36	2.0	11.0	79.2	1.1	21	6.6	110	53	
" "	"	"	" 18	62	4.0	11.7	88.9	0.6	23	6.9	80	73	
" "	"		" 30		4.5	11.8	91.2	0.8	23	6.7	130	47	
" "	"	"	" 31	290	4.5	11.9	91.7	0.6	43	6.8	95	59	
Short Creek-1½ miles below Dillonvale, Ohio	OSh	8.3	Nov. 13	41	4.0	9.2	69.9	1.0	46	6.5	132	31	
" "	"	"	" 26	52	2.0	9.6	69.5	0.9	240	6.6	125	13	
" "	"	"	Dec. 6	33	2.0	11.7	84.4	0.7	23	6.6	110	66	
" "	"	"	" 18	63	4.0	12.1	92.4	0.8	150	6.9	75	71	
" "	"	"	" 30		3.5	12.0	90.1	3.4	93	6.7	2,600	63	
" "	"	"	" 31	300	3.5	12.2	91.6	0.7	39	6.8	100	52	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
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SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Piney Fork Creek - Above Piney Fork, Ohio	OShPi 12.3	Sept. 27		13.0	11.3	106.8	0.7	9	7.0	8	47	
" "	" "	Oct. 9		10.5	10.8	96.2	1.0	46	6.9	5	68	
" "	" "	" 25		9.0	10.1	87.8	0.9	43	6.6	6	93	
" "	" "	Nov. 1		9.0	10.5	90.9	0.8	23	6.9	7	87	
" "	" "	Nov. 6	6	6.5	11.1	89.9	0.7	9	7.0	22	65	
" "	" "	" 19	5	0.0	13.9	95.0	0.5	4	6.9	25	84	
" "	" "	Dec. 2	14	2.0	13.3	96.0	0.8	9	7.0	30	67	
" "	" "	" 12	9	5.0	12.4	97.0	0.6	**	6.8	23	69	
" "	" "	" 24	4	0.0	14.0	95.7	0.6	11	7.0	45	80	
Piney Fork Creek-Below Piney Fork, Ohio	OShPi 11.3	Sept. 27		13.5	10.4	99.1	1.3	1,100	7.0	24	37	
" "	" "	Oct. 9		11.0	11.0	99.1	1.9	0	6.8	25	57	
" "	" "	" 25		10.0	6.5	57.2	6.3	460	6.1	86	11	
" "	" "	Nov. 1		9.5	8.3	72.3	6.7 15.1*	0	4.9	58	12	
" "	" "	" 6	6	7.0	8.6	70.7	2.5	93	6.7	61	25	
" "	" "	" 19	5	1.0	9.5	66.5	2.2	93	6.6	55	39	
" "	" "	Dec. 2	14	1.0	12.9	90.7	1.1	43	6.9	100	94	
" "	" "	" 12	9	5.0	11.1	86.9	0.8	93	6.6	40	53	
" "	" "	" 24	5	1.0	13.3	93.3	0.8	43	6.9	40	67	
Short Creek - Mouth Ohio Route #7	OSh 0.2	Nov. 14	43	4.0	6.2	47.2	1.6	46	6.0	138	9	
" "	" "	" 27	155	3.5	11.8	88.9	2.0	93	6.9	250	36	
" "	" "	Dec. 9	75	1.5	11.4	81.2	1.0	93	6.7	130	50	
" "	" "	" 19	55	1.0	12.0	84.3	0.5	93	6.8	130	60	
" "	" "	Jan. 2	330	6.5	11.1	89.8	0.6	240	6.8	120	70	
Wheeling Creek- Mouth W. Va. Route #2	OWh 0.1	Nov. 4		9.0	10.3	88.6	2.0	110	6.5	24	83	
" "	" "	" 6		10.0	9.6	84.8	1.9	1,100	6.7	23	95	
" "	" "	" 14	203	6.0	10.9	87.3	1.4	1,100	6.9	28	92	
" "	" "	" 22	184	10.5	9.3	82.6	2.7	430	6.5	30	90	
" "	" "	" 28	450	3.0	12.1	89.9	1.6	430	6.8	45	63	
Wheeling Creek - Mouth W. Va. Route #2	OWh 0.1	Dec. 6	175	0.5	13.0	90.0	3.1	2,400	6.8	30	101	
" "	" "	" 12	281	5.0	12.0	93.5	2.8	930	6.7	25	89	
" "	" "	" 20	181	4.5	12.0	92.6	2.1	4,600	6.9	21	82	
" "	" "	" 24		2.0	12.2	88.2	2.0	430	6.9	23	84	
Wheeling Creek-2½ miles Below Flushing, Ohio	OWh 24.7	May 10	3	13.0	9.9	93.6	0.9	4	7.0		86	
" "	" "	" 13	2	20.0	8.8	96.4	0.9	9	7.2			
" "	" "	" 15	1	17.0	9.0	92.6	0.8	4	7.2			
Wheeling Creek - 1½ mi. below Laferty, Ohio	OWh 23.7	May 10	8	11.5	9.1	82.7	0.5	4	6.6	55	35	380
" "	" "	" 13	6	18.0	7.6	79.6	0.3	1	6.5	38		404
" "	" "	" 15	4	17.0	4.3	43.9	0.1	**	6.0	63		244
Wheeling Creek-1½ miles Above Fairpoint, Ohio	OWh 20.2	Sept. 30		13.5	7.9	75.6	0.6	0	6.8	60	36	
" "	" "	Oct. 18		7.0	8.3	67.9	1.2	1	6.2	19	11	
" "	" "	" 29		9.5	10.0	87.3	1.2	**	6.3	24	15	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
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SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
Wheeling Creek-1½ miles Above Fairpoint, Ohio	OWh	20.2	Nov. 4		7.0	10.9	89.3	0.9	24	6.4	45	92	
" "	"	"	" 13	17	3.0	11.9	88.1	0.9	8	6.8	49	98	
" "	"	"	" 26	16	1.0	12.6	88.5	0.8	2	6.9	45	119	
" "	"	"	Dec. 6	15	0.0	11.9	81.4	0.7	**	6.3	70	90	
" "	"	"	" 18	17	3.5	12.4	93.3	0.9	11	6.7	45	113	
" "	"	"	" 30		4.0	12.3	93.7	0.9	9	6.4	60	59	
" "	"	"	" 31	56	4.0	12.3	93.9	0.6	24	6.6	55	77	
Wheeling Creek- ½ mile Below Fairpoint, Ohio	OWh	16.2	Sept. 30		13.5	5.6	53.4	2.0	0	6.5	50	21	
" "	"	"	Oct. 18		7.0	4.6	38.1	2.9	5	6.0	12	158	
" "	"	"	" 29		9.5	10.2	89.3	4.9	9	6.2	23	8	
" "	"	"	Nov. 4		7.0	10.8	88.3	0.6	24	6.4	93	72	
" "	"	"	" 13	18	3.0	11.5	85.2	0.6	4	6.8	72	98	
" "	"	"	" 26	19	1.0	11.8	83.1	Broke	1	6.6	55	105	
" "	"	"	Dec. 6	16	0.0	12.0	82.0	0.6	**	6.5	50	98	
" "	"	"	" 18	18	3.5	12.3	92.7	0.4	2	6.8	40	113	
" "	"	"	Dec. 30		4.0	12.1	92.0	1.2	2	6.5	130	57	
" "	"	"	" 31	60	4.5	72.1	93.6	0.3	24	6.7	65	79	
Town Run-Below south sewage plant - St. Clairsville, Ohio	OWhT	13.2	Sept. 30		14.5	3.1	30.2	14.2	43	7.3	13	240	
" "	"	"	Oct. 18		9.5	4.5	39.6	5.9	1,100	6.6	14	209	
" "	"	"	" 29		11.5	2.1	18.8	30.9	2,400	6.8	32	225	
" "	"	"	Nov. 4		10.0	8.4	73.8	7.9	4,600	6.8	10	182	
" "	"	"	" 13	**	6.0	8.9	71.6	9.5	4,600	7.1	10	180	
" "	"	"	" 26	**	6.0	7.6	60.7	19.6	24,000	7.3	130	197	
" "	"	"	Dec. 6		3.5	9.2	69.1	19.9	7,900	6.9	30	165	
" "	"	"	" 18	**	6.0	10.1	80.8	12.9	1,500	7.0	20	144	
" "	"	"	" 30		5.5	10.9	86.5	12.4	4,300	6.8	40	71	
" "	"	"	" 31	**	6.5	10.9	88.3	17.0	360	6.8	70	89	
Wheeling Creek- ½ mile Above Barton, Ohio	OWh	10.7	Sept. 30		15.5	5.0	49.8	2.5	4	6.7	31	19	
" "	"	"	Oct. 18		9.0	11.0	94.8	3.6 1.9*	**	3.3	21		
" "	"	"	Oct. 29		10.5	10.0	89.4	3.3 1.0*	**	3.4	33		
" "	"	"	Nov. 4		8.0	11.0	92.8	0.8	2	6.8	66	51	
" "	"	"	" 13	32	3.5	12.2	92.1	0.9	5	7.2	85	76	
" "	"	"	" 26	38	1.0	12.3	86.5	0.4	4	7.2	80	68	
" "	"	"	Dec. 6	38	1.0	13.3	93.6	0.6	9	6.9	100	98	
" "	"	"	" 18	26	3.5	12.6	95.0	0.6	4	7.2	80	111	
" "	"	"	" 30		4.0	12.0	91.6	1.2	15	7.0	150	68	
" "	"	"	" 31	84	4.5	12.3	94.5	0.4	24	7.0	90	88	
Wheeling Creek- ⅝ mile Below Barton, Ohio	OWh	9.2	Sept. 30		15.5	9.7	96.5	8.3 1.2*	0	4.7	33	6	
" "	"	"	Oct. 18		8.5	11.4	97.2	7.4 2.1*	0	3.4	14		
" "	"	"	" 29		10.5	10.4	92.7	5.5 1.0*	1	3.3	31		
" "	"	"	Nov. 4		7.5	11.5	95.6	1.6	24	6.6	99	32	
" "	"	"	" 13	32	3.5	13.1	98.5	0.5	8	6.7	106	45	
" "	"	"	" 26	39	1.0	10.6	74.8	1.7	4	6.7	95	25	
" "	"	"	Dec. 6	39	1.0	13.4	94.1	0.6	4	6.8	95	93	

TABLE M-7 MINOR TRIBUTARY BASINS

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SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Wheeling Creek-½ mile Below Barton, Ohio	OWh 9.2	Dec. 18	27	3.5	12.1	90.8	0.6	9	7.1	90	99	
" "	" "	" 30		4.5	11.9	91.5	0.7	8	6.0	150	66	
" "	" "	" 31	88	4.5	12.0	92.9	0.3	4	7.0	95	84	
Wheeling Creek - Mouth- Ohio Route No. 7	OWh 0.2	Nov. 14	35	4.0	12.3	93.9	2.6	1,100	6.7	94	59	
" "	" "	" 27	145	4.0	12.8	97.7	2.7	910	7.0	250	70	
" "	" "	Dec. 9	68	2.0	13.3	96.0	1.1	230	6.9	95	100	
" "	" "	" 19	40	1.0	13.4	94.3	0.5	43	7.1	45	109	
" "	" "	Jan. 2	267	6.5	11.9	96.7	0.8	93	6.9	70	110	
[illegible]-Little McMahon [illegible]	OMcLmA 10.7	Sept. 30		14.5	10.2	99.2	1.9	110,000	7.4	6	210	
" "	" "	Oct. 18		10.5	6.4	57.3	11.2	9,300	6.3	13	200	
" "	" "	" 29		11.0	5.1	45.9	20.0	4,300	6.6	22	190	
" "	" "	Nov. 4		11.0	6.7	60.1	11.2	11,000	7.0	9	186	
" "	" "	" 13	**	7.0	7.8	64.1	16.7	24,000	7.3	21	195	
" "	" "	" 26	**	3.0	8.1	59.9	11.5	23,000	7.1	8	193	
" "	" "	Dec. 6		4.0	10.3	78.6	7.3	9,300	7.1	11	181	
" "	" "	" 18	**	7.0	9.9	81.2	13.2	24,000	7.1	20	161	
" "	" "	" 30		5.0	10.3	80.1	17.5	4,300	6.9	30	91	
" "	" "	" 31	**	7.0	10.0	82.3	8.6	24,000	7.0	21	124	
McMahon Creek - Mouth Ohio Route No. 7	OMc 0.2	Nov. 14	54	4.5	11.6	89.3	0.6	2	6.8	32	74	
" "	" "	" 27	167	5.0	12.0	93.6	2.1	240	7.0	140	79	
" "	" "	Dec. 9	83	4.5	12.7	98.2	0.8	9	6.9	25	105	
" "	" "	" 19	55	1.0	13.1	92.2	0.5	4	7.0	23	106	
" "	" "	Jan. 2	284	6.0	11.5	92.3	0.7	460	6.8	22	106	
S.Fk.Captina Cr.-2½ mi. Below Barnesville, Ohio	OCsBf 31.0	1940 May 10	3	10.5	10.8	96.3	2.8	240	7.9		139	
" "	" "	" 13	2	16.5	13.0	131.9	1.8	460	8.4	4		180
" "	" "	" 15	2	19.5	11.3	122.2	1.9	23	8.4	8		196
Bend Fk.-Captina Creek 3 mi.below Bethesda,O.	OCpB 27.0	May 10	1	11.5	12.2	111.0	2.2	23	7.8	7	101	148
" "	" "	" 13	1	17.0	14.4	148.2	1.6	9	8.6			
" "	" "	" 15	1	18.0	12.3	128.6	1.9	9	7.8			
Sunfish Creek- 1.1 mi. Above Woodsfield, Ohio	OSf 22.9	May 24		17.5	8.9	92.6	4.4	1,100	7.4	420	61	
" "	" "	June 4		17.5	10.6	109.7	0.8	15	7.2	2	55	
" "	" "	" 13		23.0	9.0	103.9	1.2	150	7.8	54	68	
" "	" "	" 21		14.0	10.7	103.3	0.8	23	6.9	12	65	
" "	" "	July 1		17.0	9.2	94.6	1.7	110	6.8	90	36	
" "	" "	" 18		20.5	9.7	106.7	0.9	91	8.0	12	75	
" "	" "	" 26		24.5	8.4	99.5	0.8	91	7.5	8	72	
" "	" "	Aug. 5		23.0	7.6	87.1	0.9	23	7.8	4	87	
" "	" "	" 13		23.5	8.1	94.5	1.1	24	7.9	4	94	
" "	" "	" 21		16.0	9.7	97.9	1.8	150	7.4	13	84	
" "	" "	" 29		20.0	8.8	95.5	1.0	430	7.3	13	52	
" "	" "	Sept. 6		18.0	9.7	101.6	0.4	9	6.9	4	78	
" "	" "	" 16		14.0	9.9	95.7	0.7	4	7.1	trace	90	
" "	" "	1941 Feb. 20		1.5	14.7	104.6	1.3	2	7.5	6	42	

TABLE M-7 MINOR TRIBUTARY BASINS

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SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940		Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	% Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Sunfish Creek - 1.5 mi. Below Woodsfield, Ohio	OSf	21.4	May	24		18.5	9.0	95.1	1.4	150	7.8	30	79	
" "	"	"	June	4		19.5	10.6	114.7	0.7	21	7.6	2	68	
" "	"	"	"	13		23.5	8.4	97.7	1.6	93	7.8	160	66	
" "	"	"	"	21		18.0	10.6	104.1	0.4	15	7.4	9	74	
" "	"	"	July	1		17.0	9.3	95.8	1.6	1,100	6.9	180	39	
" "	"	"	"	18		21.5	9.4	105.6	0.9	0	8.1	58	81	
" "	"	"	"	26		26.0	7.7	93.4	1.1	43	7.7	38	79	
" "	"	"	Aug.	5		23.0	4.2	48.4	1.5	23	7.9	12	97	
" "	"	"	"	13		24.0	6.4	74.4	0.9	9	7.8	14	109	
" "	"	"	"	21		16.5	9.6	98.0	1.1	110	7.6	69	95	
" "	"	"	"	29		21.5	8.7	97.5	1.2	930	7.3	54	61	
" "	"	"	Sept.	6		19.0	10.4	111.5	0.5	0	7.4	5	97	
" "	"	"	"	16		14.0	9.9	95.4	0.6	9	7.0	1	102	
" "	"	"	1941 Jan.	20		2.5	14.8	108.5	0.7	24	7.6	5	50	
Middle Island Creek St. Marys, W. Va.	OMI	0.1	July	24		27.0	6.5	80.4	1.4	23	6.8	18	32	
" "	"	"	Aug.	9		25.0	5.9	70.4	1.1	46	7.4	150	39	
" "	"	"	"	19		25.0	4.4	52.8	0.9	46	7.1	135	31	
" "	"	"	"	27		22.5	4.3	49.6	0.4	0	6.9	67	42	
" "	"	"	Sept.	4		24.5	7.2	85.5	0.7	24	7.1	62	39	
" "	"	"	"	12		17.5	7.2	74.2	0.8	24	6.8	52	39	
Little Muskingum River At Mouth	OLMu	0.1	1940 May	1		16.5	9.0	91.1	0.8	2	6.8	17	90	
" "	"	"	"	7		15.0	9.9	97.9	0.9	2	7.5	12	99	
" "	"	"	"	9		18.0	8.9	93.4	0.9	1	7.2	18	94	
" "	"	"	"	13		15.0	8.6	86.3	1.0	2	7.1	11	102	
" "	"	"	"	15		15.0	8.0	78.4	3.8	11	6.9	2,100	59	
" "	"	"	"	17		14.5	9.6	93.4	0.9	2	6.4	56	84	
" "	"	"	"	21		18.0	8.7	91.6	0.9	2	7.3	25	87	
" "	"	"	"	23		20.0	9.0	97.7	0.9	5	7.4	22	92	
" "	"	"	"	27		15.5	9.0	89.9	0.9	11	6.7	110	58	
" "	"	"	May	29		17.0	8.8	90.2	0.6	110	6.9	36	71	
" "	"	"	"	31		16.5	9.2	93.1	1.8	460	6.5	230	94	
" "	"	"	June	4		18.0	8.7	91.4	0.6	240	6.8	48	68	
" "	"	"	"	6		21.0	7.8	87.0	0.7	23	7.4	20	80	
" "	"	"	"	10		24.0	6.8	79.2	1.9	290	7.4	450	85	
" "	"	"	"	12		20.5	7.3	80.4	3.5	460	7.3	1,800	73	
" "	"	"	"	14		22.5	7.2	82.3	1.4	0	7.2	385	59	
" "	"	"	"	18		22.0	7.0	79.8	2.9	1,100	7.0	1,600	63	
" "	"	"	"	20		20.0	7.5	81.8	1.2	430	7.1	270	62	
" "	"	"	"	24		23.0	8.1	93.1	1.0	93	7.0	58	37	
" "	"	"	"	26		22.0	7.5	85.2	0.9	0	7.3	48	95	
" "	"	"	"	28		23.0	8.6	98.6	0.9	23	7.3	34	106	
" "	"	"	July	2		17.0	7.8	79.6	2.3	460	7.3	550	59	
" "	"	"	"	10		23.5	9.2	107.4	1.0	0	7.2	17	94	
" "	"	"	"	12		24.0	8.4	97.9	1.5	15	7.0	20	87	
" "	"	"	"	16		24.0	8.2	96.5	1.6	9	7.4	20	85	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Little Muskingum River At Mouth	OLmu 0.1	July 18		24.5	7.6	89.8	1.0	2	7.6	15	116	
" "	" "	" 22		27.5	6.7	83.5	1.4	9	7.8	13	123	
" "	" "	" 24		26.5	5.9	72.0	2.5	460	7.4	370	110	
" "	" "	" 26		28.0	7.2	91.3	1.5	9	7.0	235	28	
" "	" "	" 30		29.0	7.7	99.0	1.0	4	6.9	22	15	
" "	" "	Aug. 1		27.0	6.9	85.4	1.8	46	7.2	200	40	
" "	" "	" 5		27.5	8.0	100.3	1.2	2	6.8	9	15	
" "	" "	" 7		26.5	7.4	90.8	1.4	24	7.4	15	20	
" "	" "	" 9		25.5	6.1	73.1	1.6	110	7.0	395	66	
" "	" "	" 13		27.5	7.2	90.0	1.3	0	7.1	12	12	
" "	" "	" 15		27.0	7.1	87.8	1.0	8	6.5	14	11	
" "	" "	" 19		26.5	7.1	87.2	1.0	11	6.2	32	17	
" "	" "	" 21		25.0	8.1	97.1	0.7 0.3*	0	5.8	7		
" "	" "	" 23		24.5	8.6	102.2	0.3 1.0*	**	5.4	4		
" "	" "	" 27		24.0	8.2	95.6	0.5	2	6.3	11	8	
" "	" "	" 29		21.5	6.2	69.7	3.	460	6.8	1,650	76	
" "	" "	Sept. 4		23.0	8.4	96.9	1.2	0	6.5	52	39	
" "	" "	" 6		23.5	8.2	95.6	0.3	9	6.0	12	10	
" "	" "	" 10		22.5	8.5	97.5	0.6 1.1*	15	5.3	10	6	
" "	" "	" 12		20.5	8.9	97.7	0.2 0.9*	2	5.6	12	11	
" "	" "	" 16		20.0	9.3	101.0	1.0 1.0*	1	4.5	3	5	
" "	" "	1941 Jan. 15		1.0	13.5	94.6	0.6	1	6.7	5	93	
" "	" "	" 17		4.0	12.4	94.3	1.0	11	6.8	60	69	
" "	" "	" 21		0.5	13.7	94.7	1.1	2	7.7	21	36	
" "	" "	" 23		2.0	13.5	97.7	1.0	46	7.3	45	66	
" "	" "	" 27		2.5	13.0	95.2	1.3	7	7.1	120	42	
" "	" "	" 29		1.5	13.0	92.5	1.3	4	7.2	60	46	
" "	" "	" 31		1.5	13.4	95.5	0.6	93	7.3	25	65	
" "	" "	Feb. 4		0.5	13.4	92.8	1.6	4	7.5	12	80	
" "	" "	" 6		1.5	13.4	95.5	0.4	**	7.4	7	82	
" "	" "	Mar. 6		0.5	13.4	93.1	2.0	9	7.5	140	95	
" "	" "	" 10		1.0	13.7	96.5	0.9	9	7.6	25	64	
" "	" "	1941 Mar. 12		2.0	12.8	92.6	1.2	4	7.5	130	45	
" "	" "	" 14		1.5	13.2	94.2	0.6	9	7.4	35	48	
" "	" "	" 18		0.0	13.6	93.2	0.9	4	7.6	15	67	
" "	" "	" 20		1.0	14.0	98.4	0.6	**	7.7	7	73	
" "	" "	" 24		5.0	12.9	100.9	0.9	0	7.8	18	117	
" "	" "	" 26		5.0	12.2	95.5	0.7	1	7.4	8	82	
" "	" "	" 28		5.5	12.5	99.1	0.7	0	7.6	12	86	
Duck Creek-city limits Above Caldwell, Ohio	OD 37.1	1940 May 24		18.5	7.6	80.3	4.9	1,100	7.7	550	91	
" "	" "	June 4		22.0	8.2	93.1	1.1	7	7.5	36	117	
" "	" "	" 13		25.0	7.5	89.5	1.0	43	7.8	120	92	
" "	" "	" 21		17.0	8.5	87.3	0.6	23	7.2	48	119	
" "	" "	July 1		19.0	8.2	88.1	2.8	460	7.1	430	64	
" "	" "	" 18		24.0	8.5	99.8	1.2	36	8.0	38	137	
" "	" "	" 26		28.5	7.3	93.2	2.0	9	7.7	41	153	
" "	" "	Aug. 5		26.0	6.4	77.3	1.6	0	8.0	52	142	

TABLE K-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940		Average Discharge c.f.s.	Temp °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
							p.p.m.	% Sat.						
Duck Creek-city limits above Caldwell, Ohio	OD	37.1	Aug.	13		26.5	6.1	75.1	1.6	2	7.8	18	136	
" "	"	"	"	21		20.0	5.6	61.0	1.8	24	7.5	112	127	
" "	"	"	"	29		24.0	6.1	71.8	2.1	430	7.1	490	89	
Duck Creek - 1.6 miles Below Caldwell, Ohio	OD	34.6	May	24		18.5	6.6	70.4	6.4	1,100	None	400	117	
" "	"	"	June	4		22.5	7.8	89.7	1.0	43	7.5	36	119	
" "	"	"	"	13		26.0	6.8	82.1	2.1	150	7.8	440	84	
" "	"	"	"	21		18.0	7.6	79.8	1.1	93	7.4	57	124	
" "	"	"	July	1		18.5	8.2	86.9	3.6	2,400	7.3	450	69	
" "	"	"	"	18		24.5	6.1	71.7	1.8	0	7.9	45	127	
" "	"	"	"	26		28.0	7.8	98.9	3.9	23	7.7	27	151	
" "	"	"	Aug.	5		25.0	6.2	73.6	3.0	24	8.0	63	160	
" "	"	"	"	13		26.0	6.2	75.8	2.8	24	7.6	71	160	
" "	"	"	"	21		20.0	5.8	63.2	3.1	110	7.3	138	138	
" "	"	"	"	29		24.5	5.6	66.4	3.3	430	7.3	1,125	96	
Duck Creek - Mouth	OD	0.2	May	7		15.5	9.9	98.9	1.1	4	7.7	8	120	
" "	"	"	"	9		17.5	8.9	92.3	1.3	46	7.4	24	121	
" "	"	"	"	13		15.0	8.6	84.2	3.4	9	[illegible].3	9	125	
" "	"	"	"	15		17.0	8.3	84.8	1.0	24	[illegible]	22	127	
" "	"	"	"	17		14.5	9.5	92.5	0.8	4	[illegible].6	56	85	
" "	"	"	"	21		18.0	9.6	100.3	2.1	110	7.3	11	120	
" "	"	"	"	23		20.5	8.1	88.9	1.7	93	7.5	13	123	
" "	"	"	"	27		16.0	8.3	83.4	1.7	43	7.0	185	84	
" "	"	"	"	29		17.0	8.4	86.7	1.0	43	7.0	48	102	
" "	"	"	"	31		15.5	8.8	87.8	2.0	240	6.7	340	90	
" "	"	"	June	4		19.0	8.4	89.7	0.9	460	7.0	55	104	
" "	"	"	"	6		22.0	7.8	87.9	0.9	39	7.5	17	116	
" "	"	"	"	10		23.0	6.1	69.8	2.8	290	7.5	1,200	99	
" "	"	"	"	12		21.5	7.0	78.9	2.6	460	7.6	1,100	70	
" "	"	"	"	14		24.0	6.4	75.4	1.0	210	7.5	460	105	
" "	"	"	"	18		22.0	7.0	79.3	4.0	11,000	7.2	1,550	51	
" "	"	"	June	20		21.5	7.2	80.9	1.4		7.4	270	95	
" "	"	"	"	24		22.5	7.5	86.1	1.0		7.5	55	59	
" "	"	"	"	26		21.5	7.7	86.8	1.0	43	7.5	55	135	
" "	"	"	"	28		22.5	8.3	94.6	1.6	43	7.6	51	36	
" "	"	"	July	2		18.0	7.7	80.3	1.9	240	7.2	500	94	
" "	"	"	"	10		23.5	7.4	85.6	2.2	43	7.3	23	136	
" "	"	"	"	12		23.5	6.8	79.1	2.6	150	7.2	107	125	
" "	"	"	"	16		23.5	7.5	87.3	1.5	150	7.4	15	116	
" "	"	"	"	18		23.5	6.2	71.8	2.4	36	7.6	25	133	
" "	"	"	"	22		27.0	4.4	54.6	1.5	1,100	7.4	25	138	
" "	"	"	"	24		27.0	3.5	42.9	1.7	91	7.5	24	128	
" "	"	"	"	26		27.5	7.2	90.1	1.4	110	7.0	80	29	
" "	"	"	"	30		28.5	6.1	78.1	1.0	15	7.3	23	61	
" "	"	"	Aug.	1		26.5	4.0	49.1	2.3	110	7.0	151	40	
" "	"	"	"	5		27.0	7.6	94.4	1.1	4	7.1	12	23	
" "	"	"	"	7		26.0	5.2	62.8	1.8	110	7.6	78	46	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940-41	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Duck Creek - Mouth	OD	0.2	Aug. 9		25.5	6.0	72.3	1.7	4	7.1	64	61	
" "	"	"	" 13		27.5	6.8	85.5	1.3	9	7.2	14	21	
" "	"	"	" 15		27.0	6.4	79.3	1.2	4	6.8	21	24	
" "	"	"	" 19		26.5	5.8	71.1	1.5	15	6.5	68	30	
" "	"	"	" 21		[illegible]	7.1	84.1	0.8	2	6.5	17	17	
" "	"	"	" 23		24.5	8.1	95.4	0.8 1.3*	2	5.9	7		
" "	"	"	" 27		24.0	8.0	94.1	0.6	4	6.6	8	9	
" "	"	"	" 29		21.5	6.3	71.0	3.5	2,400	7.1	1,300	100	
" "	"	"	Sept. 4		21.5	6.6	74.0	1.8	93	6.8	78	94	
" "	"	"	" 6		23.0	7.7	88.5	1.1	46	6.4	21	25	
" "	"	"	" 10		22.0	8.7	98.4	0.9	9	6.1	15	13	
" "	"	"	" 12		20.0	8.6	94.3	0.7	110	6.0	16	19	
" "	"	"	" 16		20.0	9.1	99.3	0.7 1.1*	4	5.2	8	10	
" "	"	"	1941 Jan. 15		1.0	13.6	95.9	0.7	4	7.0	5	123	
" "	"	"	" 17		3.5	12.5	94.1	1.3	2	6.9	85	31	
" "	"	"	" 21		0.5	13.5	93.5	1.9	15	7.1	15	103	
" "	"	"	Jan. 23		1.5	13.7	97.5	0.9	15	7.5	50	106	
" "	"	"	" 27		2.0	13.2	95.4	1.5	43	7.3	130	70	
" "	"	"	" 29		1.0	13.2	92.8	1.2	93	7.5	65	74	
" "	"	"	" 31		1.0	13.2	92.9	0.8	23	7.5	23	93	
" "	"	"	Feb. 4		0.5	13.1	90.8	0.6	9	7.7	15	110	
" "	"	"	" 6		1.5	13.5	96.1	0.4	2	7.6	5	108	
" "	"	"	Mar. 6		0.5	13.6	94.2	1.3	4	7.6	50	95	
" "	"	"	" 10		0.5	13.6	94.7	1.0	4	7.7	25	101	
" "	"	"	" 12		2.5	12.9	94.2	2.8	12	7.4	160	82	
" "	"	"	" 14		1.5	13.2	93.9	2.1	24	7.5	55	83	
" "	"	"	" 18		0.0	13.7	93.7	0.4	2	7.8	15	104	
" "	"	"	" 20		1.5	14.1	100.3	0.6	2	7.8	7	114	
" "	"	"	" 24		5.5	13.0	102.5	0.8	4	7.7	22	82	
" "	"	"	" 26		5.5	12.6	99.5	1.2	2	7.8	16	120	
" "	"	"	" 28		5.0	12.2	95.7	1.6	2	7.8	12	120	
Shade River - Mouth	08h	0.1	May 24		20.0	7.7	84.1	1.3	9	7.3	50	102	
" "	"	"	June 3		18.0	8.0	84.1	1.1	23	6.9	80	64	
" "	"	"	" 11		24.0	6.6	77.8	1.5	43	7.6	335	83	
" "	"	"	" 17		23.5	6.9	80.2	1.8	240	7.4	700	92	
" "	"	"	" 25		22.0	7.4	83.5	2.0	460	7.2	690	77	
" "	"	"	July 1		22.0	7.6	85.9	0.8	36	7.3	98	71	
" "	"	"	" 9		23.0	8.7	100.2	1.3	4	7.2	34	59	
" "	"	"	" 15		24.5	8.7	103.0	1.6	9	7.4	14	41	
" "	"	"	" 23		27.0	7.8	96.2	1.1	9	7.3	9	43	
" "	"	"	" 29		29.0	7.1	90.9	1.2	24	7.3	57	45	
" "	"	"	Aug. 6		28.0	7.9	99.4	1.8	9	7.6	11	32	
" "	"	"	" 12		29.0	8.2	106.2	1.0	2	7.8	7	27	
" "	"	"	" 20		25.0	5.8	69.4	1.1	4	7.2	48	53	
" "	"	"	" 26		24.5	7.8	92.9	0.8	24	7.8	11	33	
" "	"	"	Sept. 3		22.5	7.7	87.6	1.5	46	7.1	145	45	
" "	"	"	" 9		23.5	8.5	98.7	1.0	4	6.8	14	30	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Pinchin Fork-Bridge in McArthur, Ohio	ORaELP 66.0	Apr. 17	142	11.5	10.6	97.1	0.3	110	6.0			
" "	" "	" 19	399	8.5	10.9	93.2	1.8	150	6.1	310	12	
" "	" "	" 22	155	6.5	11.9	96.8	0.8 0.7*	3	4.8			
Pinchin Fk.-½ mi. below sewage plt.-McArthur, O.	ORaELP 64.0	Apr. 17	142	11.0	10.2	92.4	2.2	110	6.0	300		
" "	" "	" 19	399	7.5	10.7	89.1	2.9	23	5.7	425	4	50
" "	" "	" 22	155	7.0	11.4	94.0	1.8	36	4.8	99		
Raccoon Creek - 1 mile Above Wellston, Ohio	ORa 55.0	Apr. 17	64	12.5	9.8	91.5	4.4	240	6.1			
" "	" "	" 19	181	8.5	11.0	93.4	1.4	93	6.0			
" "	" "	" 22	70	8.5	10.6	90.7	1.2	7	6.1			
Raccoon Creek - 1 mile Below Wellston, Ohio	ORa 53.0	Apr. 17	64	12.0	6.7	60.0	2.8	1,100	6.1	260	23	
" "	" "	" 19	181	9.5	9.9	86.5	1.4	1,500	6.2	275	22	54
" "	" "	" 22	70	11.5	7.2	65.7	1.8	93	6.1	67	68	
		1939-40										
Twelvepole Creek - .7 Above Wayne, W. Va.	OTw 25.0	Dec. 15		0.0	12.3	83.9	0.5	3				
" "	" "	1940 Jan. 19		0.0	12.5	85.4	1.2	**				
" "	" "	Feb. 2		0.0	11.3	77.1	0.6	**	6.6	5		
" "	" "	" 16		0.0	13.9	94.9	1.8	9				
" "	" "	" 23		2.5	12.8	93.7	0.7	43				
" "	" "	Mar. 15		4.0	12.5	95.3	0.5	4				
" "	" "	" 29		11.0	10.4	93.6	0.2	4				
Twelvepole Creek-Corp. limit - Below Wayne, W. Va.	OTw 24.0	Dec. 15		2.0	9.4	67.7	2.3	43	7.0	6	44	
" "	" "	1940 Jan. 19		0.0	13.1	89.7	1.0	110	6.6	6	20	
" "	" "	Feb. 2		0.0	8.8	60.3	0.7	75	6.7	5	23	
" "	" "	" 16		0.0	13.7	93.8	0.6	9	6.5	37	13	
" "	" "	" 23		2.0	12.6	91.3	0.6	15	6.8	18	12	
" "	" "	Mar. 15		3.5	12.3	92.8	0.7	43	6.6	16	19	
" "	" "	" 29		11.0	10.2	92.4	0.4	43	6.9	5	22	
Little Sandy R.-4.1 mi. Above Grayson, Kentucky	OLs 32.1	June 30		23.5	6.3	73.0	1.0	21	7.5	130	60	
" "	" "	July 14		24.0	6.6	77.8	0.6	9	7.5	20	56	
" "	" "	" 28		24.0	6.7	78.7	1.9		7.2	1,400	45	
" "	" "	Aug. 11		20.5	6.7	73.8	0.9	9	7.5	38	76	
" "	" "	" 25		21.5	6.8	76.9	1.5	43	7.6	95	66	
" "	" "	Sept. 8		22.0	6.5	73.5	0.6	9	7.6	30	88	
" "	" "	" 22		16.5	6.3	63.9	1.0	24	7.5	22	90	
" "	" "	Oct. 6		16.5	7.1	72.1	1.1	9	7.8	22	85	
" "	" "	" 20		11.0	7.8	70.3	1.1	43	7.6	10	92	
" "	" "	Nov. 3		6.0	9.4	75.4	1.1	43	7.5	80	70	
" "	" "	" 17		5.5	10.4	82.0	1.0	0	7.2	18	81	
" "	" "	Dec. 1		7.0	11.2	92.1	0.6	4	7.5	12	85	
" "	" "	" 22		2.0	12.1	87.5	0.5	9	7.5	17	83	
" "	" "	1940 Jan. 12		1.5	12.2	86.8	0.5	**				
" "	" "	Feb. 8		1.0	13.2	92.8	1.0		7.5	75	39	
" "	" "	Mar. 1		4.0	12.4	94.1	0.5	8	6.7	25	7	
" "	" "	" 29		2.5	11.3	93.9	0.2	0				

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Little Sandy River-0.4 Below Grayson, Kentucky	OLe	27.6	June 30	52	23.5	5.5	63.7	0.5	240	7.5	170	51	
" "	"	"	July 14	60	24.0	6.4	75.2	0.4	23				
" "	"	"	" 26		24.0	7.1	83.6	0.8	110	7.4	175	56	
" "	"	"	Aug. 11	38	21.0	6.2	66.4	0.6	23				
" "	"	"	" 25	44	22.0	6.4	72.5	1.2	43	7.7	120	58	
" "	"	"	Sept. 8	40	22.0	6.2	70.3	0.7	75				
" "	"	"	" 22	27	17.0	4.5	46.2	1.0	460				
" "	"	"	Oct. 6	45	16.5	7.0	71.4	0.8	93				
" "	"	"	" 20	34	10.5	6.1	54.6	1.3	43				
" "	"	"	Nov. 3	43	6.5	8.3	67.1	1.6	43			61	
" "	"	"	" 17	35	5.5	9.0	70.9	1.2	93				
" "	"	"	Dec. 1	41	6.0	10.6	84.8	1.0	75				
" "	"	"	" 22	47	2.5	11.0	80.5	0.6	9				
" "	"	"	1940 Jan. 12	48	2.0	11.1	80.1		93				
" "	"	"	Feb. 8	355	1.0	13.0	91.3	1.0	21	7.5			
" "	"	"	Mar. 1	758	4.5	12.4	95.8	0.6	9				
" "	"	"	" 22	250	7.5	11.1	92.4	0.2	0				
			1939										
Little Sandy River 1.6 below Grayson, Ky.	OLe	26.2	Aug. 11		22.0	5.6	63.6	1.0	460	7.4	42	64	
" "	"	"	" 25		21.5	6.3	70.4	1.6	230	7.8	110	57	
" "	"	"	Sept. 8		22.0	5.9	66.8	1.3	460	7.6	35	83	
" "	"	"	" 22		16.0	4.7	47.6	2.2	460	7.3	35	74	
" "	"	"	Oct. 6		16.5	6.5	66.0	0.8	460	7.9	22	85	
" "	"	"	" 20		10.5	5.6	50.0	1.4	460	7.6	10	80	
" "	"	"	Nov. 3		6.5	7.6	61.4	1.8	460	7.5	90	58	
" "	"	"	" 17		5.0	8.0	62.5	1.7	240	7.0	22	69	
" "	"	"	Dec. 1		6.0	9.4	75.6	1.1	230	7.5	12	73	
" "	"	"	" 22		2.5	10.1	74.2	1.0	150	7.5	17	72	
" "	"	"	1940 Jan. 12		2.0	10.3	74.7	1.4	240	6.8	8	72	
" "	"	"	Feb. 8		1.0	13.0	91.1	1.1	15	7.5	75	42	
" "	"	"	Mar. 1		4.0	12.5	95.1	0.5	23	6.7	27	17	
" "	"	"	" 22		6.5	11.1	90.4	0.0	9	6.8	10	26	
			1939										
Little Sandy River-Mouth	OLe	0.1	June 2	96	27.0	6.5	80.2	1.7	43		20	35	
" "	"	"	" 6	115	23.0	7.0	80.5	1.7	43		18	38	
" "	"	"	" 8	83	24.0	6.8	79.1	1.5	23		32	36	
" "	"	"	" 12	140	21.5	6.9	77.8	2.7	460		1,300	22	
" "	"	"	" 14	106	21.0	7.3	81.4	1.3	43		160	34	
" "	"	"	" 16	86	22.0	7.2	81.3	1.0	23		57	39	
" "	"	"	" 20	196	24.0	6.5	76.3	1.2	4		52	39	
" "	"	"	" 22	273	24.5	6.5	76.9	0.7	46		100	37	
" "	"	"	" 26	98	24.5	6.7	79.5	1.3	9	7.3	55	46	
" "	"	"	" 28	91	24.5	6.7	79.3	0.9	0	7.2	65	42	
" "	"	"	" 30	100	24.0	6.3	73.4	0.9	46	7.2	150	39	
" "	"	"	July 6	7,680	22.5	5.8	66.6	2.7		7.4	2,500	34	
" "	"	"	" 10	279	25.0	6.8	81.3	0.9	75	7.4	550	22	
" "	"	"	" 12	157	23.5	7.5	87.2	0.4	43	7.2	65	32	
" "	"	"	" 14	115	24.0	7.2	84.2	0.6	4	7.5	50	26	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939		Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
L. Sandy River - Mouth	OLs	0.1	July	18	86	23.5	7.7	89.8	1.3	110	7.3	30	39	
" "	"	"	"	20	557	22.5	7.2	82.3	1.9	1,100	7.2	400	42	
" "	"	"	"	24		23.0	7.6	87.2	0.8	36	7.2	100	42	
" "	"	"	"	26		24.0	7.2	84.5	0.7	240	7.2	125	37	
" "	"	"	"	28		24.5	7.0	82.5	0.7	23	7.2	85	36	
" "	"	"	Aug.	1	173	24.0	7.2	83.6	0.9	240	7.4	45	46	
" "	"	"	"	3	106	24.5	7.3	86.6	0.5	23	7.3	40	50	
" "	"	"	"	7	88	25.0	7.1	84.2	1.0	75	7.4	75	42	
" "	"	"	"	9	83	25.0	7.0	83.4	0.9	240	7.3	35	44	
" "	"	"	"	11	73	24.5	7.3	86.4	1.1	1,100	7.4	20	47	
" "	"	"	"	15	225	24.0	6.6	87.6	1.3	91	7.4	220	36	
" "	"	"	"	17	716	14.5	7.1	83.7	0.7	93	7.3	50	49	
" "	"	"	"	21	225	23.5	7.2	83.5	1.3	93	7.4	880	29	
" "	"	"	"	23	111	23.0	7.3	84.3	0.9	460	7.4	250	29	
" "	"	"	"	25	89	24.0	7.2	84.2	1.0	210	7.6	90	33	
" "	"	"	Aug.	29	71	24.0	7.1	83.1	1.2	91	7.4	35	36	
" "	"	"	"	31	67	24.5	7.0	82.2	1.5	150	7.3	18	33	
" "	"	"	Sept.	5	338	24.0	6.5	75.9	1.3	43	7.4	9	44	
" "	"	"	"	7	296	24.0	7.1	83.2	1.0	93	7.3	10	42	
" "	"	"	"	11	250	24.0	6.7	78.9	1.2		7.3	12	46	
" "	"	"	"	13	236	25.0	7.4	88.6	1.0	230	7.3	7	48	
" "	"	"	"	15	227	25.5	6.7	81.1	1.0	390	7.5	6	48	
" "	"	"	"	19	200	24.0	7.2	84.1	1.1	230	7.4	8	51	
" "	"	"	"	21	361	22.0	7.0	79.2	0.7	150	7.2	6	46	
" "	"	"	"	25	196	21.5	7.6	85.1	1.2	930	7.5	12	48	
" "	"	"	"	27	186	21.5	7.9	88.3	0.8	230	7.6	6	49	
" "	"	"	"	29	158	22.5	7.5	85.9	0.8	240	7.8	5	53	
" "	"	"	Oct.	3	108	18.0	8.0	83.9	1.0	430	7.7	11	54	
" "	"	"	"	5	90	19.0	8.0	85.3	0.8	230	7.6	20	47	
" "	"	"	"	9	77	20.5	7.9	87.2	0.7	23	7.7	8	50	
" "	"	"	Oct.	11	77	20.5	7.7	84.9	0.9	430	7.5	15	52	
" "	"	"	"	13	67	18.0	7.9	82.6	0.9	230	7.9	9	47	
" "	"	"	"	17	58	15.5	9.0	89.3	0.9	230	7.6	8	43	
" "	"	"	"	19	63	15.0	9.0	88.7	0.9	240	7.4	12	[illegible]	
" "	"	"	"	23	60	15.0	8.5	83.4	0.8	150	7.6	14	44	
" "	"	"	"	25	31	15.5	8.6	85.8	0.9	230	7.5	7	41	
" "	"	"	"	27	29	17.0	7.9	81.1	1.0	460	7.3	10	46	
" "	"	"	"	31	111	11.0	8.1	73.5	0.8	91	7.0	75	53	
" "	"	"	Nov.	2	77	10.5	9.0	80.2	1.4	3	7.4	17	68	
" "	"	"	"	6	75	7.0	9.6	79.3	1.2	24	7.2	8	71	
" "	"	"	"	8	73	7.0	9.8	80.8	1.0	15	7.2	12	67	
" "	"	"	"	10	75	6.5	9.9	80.3	1.0	24	7.4	12	71	
" "	"	"	"	14	58	10.5	10.0	89.6	1.4		7.2	13	65	
" "	"	"	"	16	65	11.0	10.5	94.6	1.0	93	7.4	13	53	
" "	"	"	"	24	81	6.0	10.1	81.2	1.0	460	7.1	14	38	

TABLE N-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
L. Sandy River - Mouth	OLs	0.1	Nov. 28	79	7.0	10.6	87.1	1.2	93	7.2	8	44	
" "	"	"	" 30	81	5.5	10.4	82.6	0.8	240	7.0	13	49	
" "	"	"	Dec. 4	81	6.0	10.6	84.9	1.0	93	7.1	15	49	
" "	"	"	" 8	75	5.5	10.9	86.3	1.0	240	7.1	13	49	
" "	"	"	" 12	75	5.0	11.3	88.3	1.1	43	7.1	8	42	
" "	"	"	" 14	81	5.0	11.2	87.8	1.4		7.1	13	45	
" "	"	"	" 18	77	4.5	11.4	88.1	0.7	23	7.3	9	52	
" "	"	"	" 20	85	6.5	11.2	91.0	0.9	240		8	40	
" "	"	"	" 22	90	4.0	11.6	88.6	0.8	58	7.3	8	45	
" "	"	"	" 27	94	3.5	12.5	94.1	0.8	9	7.0	7	55	
" "	"	"	" 29	94	1.5	12.6	89.6	1.1	21	7.2	8	46	
" "	"	"	1940 Jan. 15	820	0.5	12.5	85.4	1.0	15	7.1	27	54	
" "	"	"	" 17	384	0.5	13.5	93.8	1.1	9	6.8	90	40	
" "	"	"	Feb. 20	3,150	3.5	11.8	86.7	1.3	4	6.9	300	23	
" "	"	"	" 26	518	2.5	12.9	94.4	0.7	4	7.1	18	19	
" "	"	"	Feb. 28	2,410	3.0	12.9	95.6	0.6	24	7.1	45	23	
" "	"	"	Mar. 5	2,900	7.5	10.5	87.5	1.0	9	6.7	350	19	
" "	"	"	" 7	1,170	5.5	11.3	89.4	0.6	9	6.9	85	15	
" "	"	"	" 11	483	4.0	12.0	91.4	0.4	7	7.0	16	23	
" "	"	"	" 13	330	3.5	12.4	93.3	0.4	0	7.0	9	26	
" "	"	"	" 15	703	3.5	12.4	93.0	0.7	9	6.9	14	25	
" "	"	"	" 19	667	7.0	11.6	95.8	1.2	1	6.8	150	18	
" "	"	"	" 21	950	7.0	11.3	92.5	0.4	15	6.9	30	17	
" "	"	"	" 25	275	4.0	12.0	91.5	0.5	9	6.9	7	23	
" "	"	"	" 27	236	4.0	12.6	95.8	0.7	4	6.9	8	26	
" "	"	"	" 29	234	8.0	11.5	97.0	0.2	15	6.8	7	27	
" "	"	"	Apr. 2	2,150	10.0	9.9	87.5	1.1	46	6.8	140	14	
" "	"	"	" 4	1,190	12.0	9.3	86.0	0.8	43	6.8	65	16	
" "	"	"	" 6	490	11.5	9.4	85.8	0.4	9	6.8	15	19	
" "	"	"	" 10	376	10.0	9.6	84.4	0.4	0	6.6	7	26	
			1939										
Tygart Creek - Mouth At Highway Bridge	OTy	1.0	July 11		24.0	6.8	80.0	0.6	240	7.5	75	69	
" "	"	"	" 13		25.0	6.6	78.8	0.6	23	7.7	45	80	
" "	"	"	" 19		22.0	6.4	72.7	0.9	23	7.5	75	78	
" "	"	"	" 25		22.5	7.1	81.3	0.6	43	7.4	40	65	
" "	"	"	" 31		23.0	6.4	74.1	1.1	93	7.4	150	72	
" "	"	"	Aug. 8		23.0	6.4	74.9	1.3	9	7.5	25	83	
" "	"	"	Aug. 14		24.0	6.4	75.0	2.1	15	7.7	30	83	
" "	"	"	" 22		22.0	6.7	76.0	0.7	8	7.5	65	58	
" "	"	"	" 28		22.5	6.7	76.6	1.0	4	7.6	30	85	
" "	"	"	Sept. 5		21.5	5.8	65.2	1.0	2	7.4	16	91	
" "	"	"	" 11		21.5	5.8	65.5	1.1	2	7.5	14	93	
" "	"	"	" 19		20.5	6.4	70.8	0.8	4	7.4	8	106	
" "	"	"	" 25		17.5	6.7	69.4	0.8	2	7.6	12	107	
" "	"	"	Oct. 3		15.0	7.2	71.1	1.1	5	7.7	14	106	
" "	"	"	" 9		18.0	7.0	73.0	0.9	9	7.7	13	92	
" "	"	"	" 17		11.5	7.9	71.8	1.1	2	7.5	13	94	
" "	"	"	" 23		11.5	7.8	65.9	1.4	2	7.6	10	99	
" "	"	"	" 31		10.5	5.6	50.3	1.9	9	7.1	25	73	
" "	"	"	Nov. 6		6.0	8.5	67.8	1.6	2	7.4	10	77	
" "	"	"	" 14		5.0	8.2	63.9	1.2	1	7.2	8	90	
" "	"	"	" 20		8.0	7.0	58.8	2.1	**	7.4	12	95	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
Tygart Creek - Mouth	OTy	1.0	Nov. 28		5.5	9.1	71.9	1.0	**	7.4	23	89	
" "	"	"	Dec. 4		6.0	8.8	70.7	1.1	1	6.9	14	90	
" "	"	"	" 12		5.5	9.9	78.6	1.3	2	7.5	10	83	
" "	"	"	" 18		6.0	10.5	84.4	1.0	1	7.4	13	83	
" "	"	"	" 26		3.0	12.0	88.9	1.2	2	7.6	19	83	
			1940										
" "	"	"	Jan. 3		0.5	12.4	85.9	1.2	0	7.2	14	85	
" "	"	"	" 15		3.0	11.5	85.1	0.7	5	7.1	25	84	
" "	"	"	Feb. 12		5.5	12.4	98.1	1.3	4	7.4	225	38	
" "	"	"	" 20		4.5	12.3	94.6	1.4	4	7.1	260	41	
" "	"	"	" 26		3.0	[illegible]	93.6	0.7	4	7.3	17	41	
" "	"	"	Mar. 5		8.0	11.0	92.6	1.0	46	7.0	210	32	
" "	"	"	" 11		4.5	11.7	90.5	0.7	4	7.0	9	45	
" "	"	"	" 19		8.0	11.3	95.5	1.1	7	7.1	250	37	
" "	"	"	" 25		5.0	11.9	92.7	0.8	0	6.9	8	41	
" "	"	"	Apr. 2		11.5	9.9	90.2	1.1	46	6.8	110	31	
" "	"	"	" 8		13.5	9.0	85.9	0.5	2	6.7	10	43	
			1939										
Lick Creek - Above West Union, Ohio	OBrLi	15	Sept. 8		17.5	7.5	78.1	0.8	110	8.0			
" "	"	"	Oct. 5		14.0	8.5	82.3	1.1	1,100	7.9			
" "	"	"	Nov. 2		5.0	10.6	83.0	0.9	73	7.8			
" "	"	"	Dec. 13		5.0	10.6	83.1	5.4	230				
			1940										
" "	"	"	Jan. 12		0.0	12.5	85.4	5.5	240				
			1939										
Beasley Fork - Below West Union, Ohio	OBrBe	13	Sept. 8		24.0	6.4	75.6	1.5	93	7.9			
" "	"	"	Oct. 5		15.5	10.4	104.0	1.4	39	7.9			
" "	"	"	Nov. 2		5.0	12.2	95.6	0.9	23	8.0			
" "	"	"	Dec. 13		5.5	11.4	90.4	6.6	1,500				
			1940										
" "	"	"	Jan. 12		0.0	13.2	90.5	0.8	240				
			1939										
Brush Fork West Union, Ohio	OBr	14	Sept. 8		17.0	6.8	69.6	2.4	24	7.0			
White Oak Creek - Above Georgetown, Ohio	OWo	11	Aug. 1		24.5	8.1	95.4	1.1	9				
" "	"	"	Sept. 8		24.5	7.0	82.2	1.1	4	7.9			
" "	"	"	Oct. 5		17.0	9.1	93.7	1.1	**	7.9			
" "	"	"	Nov. 2		6.0	12.4	99.0	1.4	9	7.6			
" "	"	"	Dec. 13		5.5	12.0	95.3	2.5	1				
			1940										
" "	"	"	Jan. 12		0.0	13.9	94.9	3.2	1				
			1939										
White Oak Creek - Below Georgetown, Ohio	OWo	10	Aug. 1		24.0	7.6	88.7	2.9	43				
" "	"	"	Sept. 8		23.5	7.5	[illegible]	0.9	3	7.9			
" "	"	"	Oct. 5		17.5	9.6	99.9	1.2	11	7.9			
" "	"	"	Nov. 2		7.0	11.4	93.7	1.2	9	7.5			
" "	"	"	Dec. 13		6.6	11.9	96.5	0.7	4				
			1940										
" "	"	"	Jan. 12		0.0	13.2	90.2	1.0	5				

TABLE N-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Tanners Creek - Above Lawrenceburg, Indiana	OTa	0.2	July 14		24.5	6.0	70.6	1.6	9				
" "	"	"	" 26		24.0	6.6	77.4	1.2	24				
" "	"	"	Aug. 10		21.0	6.3	70.5	0.4	23				
" "	"	"	" 23		20.5	5.6	61.1	1.5	150	7.4			
" "	"	"	Sept. 20		16.0	5.8	61.1	0.8	9	7.5			
" "	"	"	Oct. 18		17.5	10.1	105.1	5.3	2	7.7			
" "	"	"	Nov. 15		5.0	18.6	146.5	3.3	1	7.6			
" "	"	"	Dec. 27		1.0	15.2	106.5	2.4	4	8.0			
" "	"	"	July 14		30.0	0.0	00.0	43.6	2,300				
" "	"	"	" 26		27.0	0.0	00.0	70.0	11,000				
" "	"	"	Aug. 10		26.0	0.0	00.0	23.0	2,300				
" "	"	"	" 23		30.0	0.0	00.0	47.2	2,400	7.5			
" "	"	"	Sept. 20		27.0	0.0	00.0	162.4	7,300	7.1			
" "	"	"	Oct. 18		27.0	0.0	00.0	68.1	24,000	7.5			
" "	"	"	Nov. 15		26.5	0.0	00.0	114.5	43,000	7.4			
" "	"	"	Dec. 27		30.0	0.0	00.0	441.5	360	7.5			
S.Fk.Hogan Creek-Above Aurora, Indiana	OHSf	0.5	July 14		26.0	7.7	93.7	3.6	24				
" "	"	"	" 26		24.5	6.4	75.5	1.9	24				
" "	"	"	Aug. 10		21.0	7.1	79.0	1.5	23				
" "	"	"	" 23		21.0	7.5	83.6	2.1	23	7.6			
" "	"	"	Sept. 20		17.0	8.6	88.3	0.9	46	7.9			
" "	"	"	Oct. 18		6.0	11.6	92.9	0.3	2	7.9			
" "	"	"	Nov. 15		1.5	12.2	87.3	3.5	24	7.8			
" "	"	"	Dec. 27		1.0	12.8	89.7	2.3	4	7.9			
South Fork Hogan Creek Above Aurora, Indiana	OHSf	0.5	July 14		26.0	6.8	83.1	3.4	110				
" "	"	"	" 26		25.5	7.8	94.3	2.8	240				
" "	"	"	Aug. 10		23.5	5.8	68.0	1.9	460				
" "	"	"	" 23		21.5	5.9	65.8	5.4	43	7.6			
" "	"	"	Sept. 20		19.0	4.2	44.9	3.0	36	7.5			
" "	"	"	Oct. 18		8.0	5.5	46.3	2.7	4	7.5			
" "	"	"	Nov. 15		3.5	7.1	53.6	6.6	1	7.5			
" "	"	"	Dec. 27		0.5	10.8	75.2	5.6	240	7.8			
Hogan Creek Below Aurora, Indiana	OH	0.0	July 14		27.0	6.8	84.6	2.4	460				
" "	"	"	" 26		25.5	5.6	67.7	2.6	230				
" "	"	"	Aug. 10		25.0	7.0	[illegible].1	2.0	460				
" "	"	"	" 23		25.5	6.1	73.0	1.7	240	7.5			
" "	"	"	Sept. 20		23.5	6.5	75.5	1.8	23	7.3			
" "	"	"	Oct. 18		15.0	7.2	71.4	1.7	1,100	7.5			
" "	"	"	Nov. 15		6.5	8.7	70.5	3.1	2,400	7.5			
" "	"	"	Dec. 27		3.0	11.6	85.8	4.1	91	7.5			
Laughery Creek Above Batesville, Ind.	OLa	40.0	July 14		26.5	4.5	57.8	6.4	240				
" "	"	"	" 26		27.5	7.8	97.9	6.1	930				
" "	"	"	Aug. 10		25.0	1.6	19.6	10.7	1				

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1939	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen		5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
						p.p.m.	% Sat.						
Laughery Creek-Below Batesville, Indiana	OLa	39.7	July 14		28.0	10.2	129.3	5.1	2,400				
" "	"	"	" 26		26.5	10.0	122.9	6.5	430				
" "	"	"	Aug. 10		25.0	8.8	104.9	6.7	930				
Laughery Creek-Above Osgood, Indiana	OLa	30.0	July 14		26.5	8.5	104.8	1.8	4				
" "	"	"	" 26		24.5	6.3	74.3	1.9	24				
" "	"	"	Aug. 10		23.5	5.7	66.3	2.3	23				
Laughery Creek-Below Osgood, Indiana	OTa	29.7	July 14		26.0	7.2	87.8	2.5	4				
" "	"	"	" 26		25.0	7.6	90.3	3.8	46				
" "	"	"	Aug. 10		23.0	5.7	65.7	1.3	9				
			1940										
N.Fk.Cedar Creek-Prison Farm-Louisville, Ky.	OHaCNf	6.8	July 29	**	29.0	5.7	73.7	25.5	24,000	7.2	70	141	
" "	"	"	" 31	**	28.5	0.0	00.0	38.6	4,300	7.1	20	80	
" "	"	"	Aug. 2	**	26.0	0.0	00.0	20.4	230	7.2	35	116	136
Harrods Creek-Mouth	OHa	0.0	Aug. 1		29.5	6.1	79.5	1.9	93	7.7	12	86	
" "	"	"	" 3		28.0	4.6	57.8	1.5	23	7.6	16	95	
" "	"	"	" 7		27.0	2.7	33.0	1.3	93	7.6	1,700	120	99
" "	"	"	" 9		27.0	3.4	42.0	1.1	93	7.7	14	118	
" "	"	"	Oct. 25		16.0	6.3	63.1	1.1	3	7.5	15	72	148
" "	"	"	" 26		None	6.4		1.1	2	7.5	15	72	
" "	"	"	1941 Jan. 27		5.5	12.2	96.8	2.2	14	7.9	38	154	
" "	"	"	" 28		5.0	12.5	97.9	0.7	23	7.9	35	173	
" "	"	"	" 29		4.0	12.6	96.3	0.9	4	7.9	31	174	140
" "	"	"	" 30		3.0	12.6	93.5	1.2	24	8.0	33	176	
" "	"	"	" 31		3.5	12.7	95.6	0.8	9	7.9	14	177	
			1940										
Goose Creek - 1 mile below Anchorage, Ky.	OGo	3.9	July 29	**	26.5	0.0	00.0	59.4	11,000	7.1	100	158	
" "	"	"	" 31	**	25.0	0.0	00.0	53.8	240,000	7.2	70	202	
" "	"	"	Aug. 2	**	21.0	0.0	00.0	42.8	93,000	7.3	70	204	148
Goose Creek - Mouth	OGo	0.0	Aug. 1		29.0	3.0	38.7	4.5	230	7.3	40	108	
" "	"	"	" 3		28.0	3.6	45.5	2.4	36	7.3	72	95	
" "	"	"	" 7		22.0	2.9	32.8	10.0	2,400	7.5	25	66	63
" "	"	"	" 9		23.5	3.1	35.9	3.7	930	7.5	75	86	
" "	"	"	Oct. 25		15.5	5.0	50.0	2.2	93	7.5	55	112	126
" "	"	"	" 26		16.5	4.4	44.7	2.0	43	7.4	55	120	
			1941										
" "	"	"	Jan. 27		5.0	10.4	80.9	4.1	93	7.8	25	171	
" "	"	"	" 28		4.0	11.1	84.3	2.5	43	7.8	13	179	
" "	"	"	" 29		3.5	11.5	86.5	1.8	150	7.8	12	181	145
" "	"	"	" 30		3.5	12.3	92.6	3.3	240	7.8	18	179	
" "	"	"	" 31		3.0	11.7	86.6	1.9	75	7.8	12	181	
			1940										
Bear Grass Creek Lexington Road	OBg	2.0	July 29	**	26.0	0.0	00.0	28.8	230	7.3	20	158	
" "	"	"	" 31	**	24.0	0.0	00.0	28.0	24,000	6.8	130	58	
" "	"	"	Aug. 2	**	22.5	0.0	00.0	10.4	4,600	7.1	35	134	
" "	"	"											

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth		Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Bear Grass Creek-Mouth Highway Bridge	OBg	0.0	Aug. 1		26.0	2.0	25.9	9.5	11,000	7.1	57	96	
" "	"	"	" 3		26.0	0.0	00.0	11.7	9,300	7.1	32	130	
" "	"	"	" 7		25.5	0.0	00.0	28.2	1,100,000	7.1	80	118	118
" "	"	"	" 9		27.0	1.8	22.2	12.0	75,000	7.2	13	106	
" "	"	"	Oct. 25		17.0	0.0	00.0	44.0	46,000	7.3	35	182	180
" "	"	"	" 26		18.0	0.0	00.0	58.4	46,000	7.3	35	224	
			1941										
" "	"	"	Jan. 27		5.5	9.8	77.2	5.1	430	7.7	30	175	
" "	"	"	" 28		5.0	11.3	88.0	6.9	430	7.7	41	184	
" "	"	"	" 29		3.5	11.5	86.7	5.8	460	7.7	25	186	189
" "	"	"	" 30		4.5	11.0	85.0	9.4	1,500	7.6	105	196	
" "	"	"	" 31		4.5	11.3	87.4	9.0	2,400	7.7	90	203	
Sanders Spring Fort Knox Intake	OOcS	6.0	Oct. 25		None	10.2		0.4	3	7.7	3	232	121
" "	"	"	" 26		16.0	10.7	107.3	0.8	1	7.7	3	224	
Otter Creek - near Fort Knox Intake	OOc	5.4	Oct. 21		13.0	10.2	96.0	2.7	3	7.7	5	204	
" "	"	"	" 22		14.0	9.4	91.0	1.9	2	7.8	8	203	
" "	"	"	" 23		16.0	9.4	94.8	2.2	2	7.8	8	204	
" "	"	"	" 24		16.0	8.2	82.0	1.4	2	7.7	8	206	197
Otter Creek Tip Top, Kentucky	OOc	3.4	Aug. 1	1	24.0	8.5	100.0	1.3	240	7.8	20	170	
" "	"	"	" 5	50	23.0	8.2	94.7	3.3	23	7.7	15	172	164
" "	"	"	" 6	50	25.0	7.9	91.9	2.9	240	7.7	20	174	
Otter Creek - Just above mouth	OOc	0.0	Oct. 19		19.0	9.3	99.8	1.8	75	7.7	13	135	
Big Indian Creek-W.Wks. Intake-Corydon, Indiana	OBi	19	Aug. 1		28.5	6.5	83.4	1.4	9	7.7	18	150	
" "	"	"	" 7		27.0	5.9	73.2	1.5	43	7.7	13	156	
" "	"	"	" 9		24.0	6.1	71.4	1.8	9	7.5	12	161	
Big Indian Creek-below sewage plant Corydon, Indiana	OBi	17	Aug. 1		28.0	7.2	91.2	7.5	4,600	7.7	30	159	
" "	"	"	" 7		27.0	4.8	59.4	9.1	46,000	7.7	30	142	132
" "	"	"	" 9		21.5	2.0	22.7	4.2	21,000	7.5	10	176	
N.Fk.Blue River- 2½ mi. below Salem, Indiana	OBB1Nf	59	Oct. 23	**	13.0	7.3	68.7	2.2	23	7.7	10	234	208
" "	"	"	" 28	**	16.0	4.8	47.9	2.3	93	7.7	12	242	
" "	"	"	" 31	**	11.0	7.0	63.2	3.8	43	7.6	13	240	
Big Blue River - Mouth	OBB1	0.1	Aug. 15		27.0	8.5	105.0	2.9	23	8.4	12	80	
" "	"	"	" 19		27.5	6.9	86.4	2.6	21	7.7	35	66	
" "	"	"	" 20		25.0	7.3	86.6	2.3	46	7.6	28	65	115
" "	"	"	" 23		24.5	8.2	97.3	1.3	240	7.7	15	62	
" "	"	"	1941 Feb. 12		5.5	13.2	104.6	0.8	4	8.0	12	159	
" "	"	"	" 14		4.5	11.9	92.0	1.4	1	7.8	15	150	174
			1940										
Cypress Creek- 1 mile Below Bennsville, Ind.	OCy	1.0	Oct. 22	1	13.5	0.0	00.0	23.0	360	7.5	10	[illegible]	
" "	"	"	" 25	1	18.0	0.0	00.0	15.0	9,300	7.4	10	275	660
" "	"	"	" 30	1	13.0	0.0	00.0	64.6	24,000	7.0	30	199	

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliform M.P.N. Per ml	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Lost Creek-Below Sewage Outfall-Morganfield, Ky	OL 9.8	Oct. 28	**	17.0	6.3	64.5	10.0	7,500	7.5	220	258	
" "	" "	" 31	**	8.5	7.0	59.7	5.2	2,400	7.6	70	256	640
" "	" "	Nov. 5	1	15.5	6.3	62.7	6.6	4,300	7.6	75	234	
Eldorado Drainage Ditch ½ mi. below Eldorado, Ill	OSa	Aug. 23	**	32.0	0.0	00.0	13.2	23,000	6.9	125	256	232
" "	"	" 26	**	33.0	0.0	00.0	40.0	24,000	7.4	88	444	
" "	"	" 27	2	None			42.2	36	2.8	550		
Trib. to Middle Fk. Saline Below Wasson, Illinois	OSaMfT	Aug. 22	1	21.0	7.8	86.3	2.5	**	3.0	5		
" "	"	" 23	1	23.0	8.0	91.7	2.1	1	3.3	5		1,765
" "	"	" 26	1	27.5	1.0	12.5	2.1	**	6.6	5		
Middle Fk. Saline River W.Wks. - Harrisburg, Ill	OSaMf	Aug. 23	1	27.5	6.0	74.8	1.8	2	3.4	5		1,075
" "	"	" 26	1	30.0	2.2	28.2	3.2	**	2.9	5		
" "	"	" 27	1	26.0	1.0	11.2	2.5	**	2.9	10		
Middle Fk. Saline River Pankey Fork	OSaMf	Aug. 23	1	25.5	5.5	66.7	10.0	43	4.7	15		192
" "	"	" 26	1	26.0	0.0	00.0	5.5	4	4.4	10		
" "	"	" 27	1	27.0	0.0	00.0	15.8	**	3.9	15		
S.Fork Saline River mi. above Junction with Middle Fork	OSaSf	Aug. 22	9	24.0	7.6	90.7	2.1	240	6.7	320	35	40
" "	"	" 23	3	26.5	7.6	95.8	2.2	23	7.1	190	37	
" "	"	" 26	1	29.0	7.3	94.0	1.9	23	7.6	120	53	
Saline River Equality, Illinois	OSa	Aug. 23	10	24.0	7.7	90.5	2.2	11	6.9	5	35	137
" "	"	" 26	4	26.0	8.0	97.6	1.8	43	7.1	5	40	
" "	"	" 27	5	27.0	7.5	93.4	2.0	4	7.0	10	37	
Saline River - Mouth	OSa 0.1	Sept. 10		24.5	7.5	88.5	1.8	9	7.7	55	92	
" "	" "	" 12		23.0	7.2	82.7	1.8	2	7.9	47	92	89
" "	" "	" 16		22.0	8.9	100.6	1.8	2	7.9	18	83	
" "	" "	" 18		22.5	9.2	105.0	1.4	9	8.3	18	85	
" "	" "	Nov. 5		15.5	8.2	81.9	1.7	8	7.7	15	91	149
" "	" "	" 7		13.5	8.9	85.3	2.2	9	7.7	15	84	
" "	" "	" 8		13.5	8.7	83.0	1.6	4	7.7	15	90	
" "	" "	1941 Feb. 26		2.0	13.3	96.2	3.5	9	7.4	13	98	148
" "	" "	" 28		1.5	13.7	97.4	2.0	2	7.5	12	95	
Tradewater R. - Above Dawson Springs, Ky.	OTr 87.5	1940 Oct. 29	**	19.5	2.3	24.4	4.6	43	6.7	25	36	42
" "	" "	Nov. 1	**	15.5	2.5	25.0	2.5	1	6.8	15	50	
" "	" "	" 6	**	8.0	2.3	19.1	1.0	**	6.7	25	46	
Tradewater R. - Below Dawson Springs, Ky.	OTr 86	Oct. 29	**	19.5	0.0	00.0	235.	93,000	6.7	140	182	96
" "	" "	Nov. 1	**	15.5	0.0	00.0	95.	75,000	6.7	80	114	
" "	" "	" 6	**	7.5	0.0	00.0	66.	240,000	6.9	60	150	
Greasy Creek-Bridge Below Burlington, Ky.	OTrGlOr 63	Nov. 12	1	10.0	7.4	65.1	0.1 6.1*	**	3.1	10		
" "	" "	" 14	**	5.5	10.7	84.6	2.6 7.7*	**	3.4	10		
" "	" "	" 18	**	10.5	9.2	82.3	12.7 13.2*	**	3.5	10		7,200
Tradewater R.-Water Wks Providence, Kentucky	OTr 41	Oct. 28	**	23.5	6.5	75.6	1.7	2	7.1	20	88	
" "	" "	" 31	**	15.0	6.5	63.8	2.7	2	7.1	50	90	
" "	" "	Nov. 5	**	12.5	7.8	72.5	2.4	8	7.2	30	76	102

TABLE M-7 MINOR TRIBUTARY BASINS

OHIO RIVER POLLUTION SURVEY
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage From Mouth	Date 1940	Average Discharge c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5 Day B.O.D. p.p.m.	Coliforms M.P.N. Per ml.	pH	Turbidity p.p.m.	Alkalinity p.p.m.	Hardness p.p.m.
Owens Creek-Below Sewage plant - Providence, Ky.	OTrO 43	Oct. 28	2	24.5	7.9	93.5	2.8 0.7*	1	3.6	130		
" "	" "	" 31	**	15.0	2.0	19.3	131.	2,300	7.1	150	238	
" "	" "	Nov. 5	**	12.5	4.6	42.6	16.0 15.5*	23	5.7	130	16	820
Cypress Creek-Below sewage plant-Sturgis, Ky	OTrCy 8	Oct. 28	**	16.0	0.0	00.0	99.0	4,300	7.4	220	312	
" "	" "	" 31	**	9.5	0.0	00.0	34.0	24,000	7.4	240	240	770
" "	" "	Nov. 5	2	15.5	4.4	43.8	12.9	2,300	6.8	170	62	
Tradewater R.-Water Wks Intake - Sturgis, Ky.	OTr 6	Oct. 28	2	18.5	4.6	48.6	1.1	4	7.3	5	84	
" "	" "	" 31	3	9.5	4.0	34.6	4.9	9	7.2	5	82	
" "	" "	Nov. 5	4	16.5	4.5	45.4	2.1	4	7.1	15	80	134
Tradewater R. - Mouth	OTr 0.2	Sept. 10	2	24.0	4.6	53.9	1.5	9	7.5	50	68	
" "	" "	" 12	1	22.5	8.6	98.8	1.3	4	7.8	23	68	85
" "	" "	" 16	1	21.5	8.7	97.8	1.6	4	7.9	27	67	
" "	" "	" 18	1	22.0	9.2	103.8	1.1	2	8.0	15	68	
" "	" "	Nov. 5	1	16.0	8.9	89.4	1.9	9	7.8	18	72	148
" "	" "	" 7	1	14.0	10.3	98.9	1.8	2	7.7	13	60	
" "	" "	" 8	1	13.5	10.2	97.5	1.7	24	7.8	12	60	
		1941										
" "	" "	Feb. 26	151	2.5	12.9	94.6	2.3	4	7.0	12	38	135
" "	" "	" 28	144	1.5	13.3	94.6	1.0	1	7.0	5	42	
		1940										
Crooked Creek-below sewage- Marion, Ky.	OCr 9.8	Oct. 28	**	21.5	1.1	12.7	23.0	4,300	7.5	15	182	
" "	" "	" 31	**	11.5	2.7	24.6	14.4	2,300	7.2	13	158	
" "	" "	Nov. 5	**	15.5	6.9	68.9	11.6	2,400	7.3	260	62	88
Town Branch-below sewage Marion, Kentucky	OCrT 9.8	Oct. 28	**	19.5	1.8	19.5	14.2	2,400	6.9	5	72	
" "	" "	" 31	**	11.5	2.0	18.6	12.6	2,400	7.0	70	256	640
" "	" "	Nov. 5	1	16.5	0.0	00.0	25.8	46,000	7.2	35	170	170
L.Cache River- 1 mile Below Anna, Illinois	OLCa 40.	Aug. 22	2	20.0	5.5	60.2	2.1	430	7.3	5	120	127

* Seeded and neutralized

** Less than one.

Table M-7A Minor Tributary Basins - Laboratory Data - Acid Stream Results

Stream	Sampling Point	Month 1940	No. Samples	pH	ACIDITY P.P.M.			IRON P.P.M.	
					Methyl Red	Phenolphthalein		Ferrous	Total
						Hot	Cold		
Chartiers Creek Mi.3 Below Pgh.	Bel. Washington, Pa. Mile 34	Oct.	3	6.1			461 (2)		280
	Bel. Houston, Pa. Mile 26	Oct.	3	6.0	33 (1)		57 (1)	16 (2)	90
	Bel. Canonsburg, Pa. Mile 23	Oct.	3	4.4	127 (2)		283 (2)	40 (2)	131 (2)
		Nov.	2	6.3				17.5(1)	55
	Bel. Morganza, Pa. Mile 21	Oct.	3	6.1			321 (1)	7 (1)	40
		Nov.	2	6.3				12.5(1)	31
Miller Run (Trib. of Chartiers Cr.)	Abv. Cecil, Pa. Mile 16.5	Oct.	4	3.0	622	1206(1)	1854	360	1190
		Nov.	3	5.1	120 (2)		1399 (2)	325 (2)	415
		Dec.	2	6.0			89 (1)	16 (1)	39
	Bel. Cecil, Pa. Mile 15.5	Oct.	4	3.0	624	1022(1)	1621	183	1390
		Nov.	3	5.6	25 (2)		675	290 (2)	384
		Dec.	2	6.1			346 (1)	80 (1)	91
Robinson Run (Trib. of Chartiers Creek)	Bel. Midway, Pa. Mile 21.5	Oct.	4	3.1	222	333(1)	275	1	67
		Nov.	2	4.5	68		104		13
		Dec.	2	4.6(1)	32 (1)		60 (1)		9 (1)
	Abv. McDonald, Pa. Mile 19	Oct.	4	2.7	689	833(1)	870	62	198
		Nov.	2	3.4	244		375	34	135
		Dec.	2	4.3	115		168	24	58
	Bel. McDonald, Pa. Mile 17.5	Oct.	4	2.9	412	652(1)	614	28	129
		Nov.	2	4.0	186		297	19	77
		Dec.	2	4.4	114		156	20	73
	Abv. Oakdale, Pa. Mile 15.5	Oct.	4	3.0	429	538(1)	544	28	90
		Nov.	3	3.9	153		205	20	77
		Dec.	2	3.8	127		195	17	57
	Bel. Oakdale, Pa. Mile 14.5	Oct.	4	2.9	410	559(1)	504	8	69
		Nov.	3	3.6	171		222	8	68
		Dec.	2	3.1	206		584	10	51
No.Robinson Run (Trib. of Chartiers Creek)	Abv. Oakdale, Pa. Mile 15.5	Oct.	4	2.8	449	584(1)	534	1.6	79
		Nov.	3	3.3	195		238	5.2	45
		Dec.	2	2.9	283		369	4.2	52
Chartiers Creek Mi. 3 Below Pgh.	Abv. Carnegie, Pa. Mile 8.5	Oct.	4	3.5	192	258(1)	312	53	181
		Nov.	3	5.5	17 (2)		158 (2)	24	101
		Dec.	2	6.1				8	30
	Bel. Carnegie, Pa. Mile 6.5	Oct.	4	3.5	211	316(1)	314	42	177
		Nov.	3	5.4	30 (2)		110 (2)	11	69
		Dec.	2	5.7			58 (1)	5	23
Raccoon Creek Mile 29.6 Below Pittsburgh	Abv. Burgettstown, Pa. Mile 32.5	Oct.	4	2.8	879	1964(1)	1985	121	368
		Nov.	2	3.7	311		818	100	280
		Dec.	2	5.1	174 (1)		205	32	132
	Bel. Burgettstown, Pa. Mile 31.5	Oct.	4	2.7	640	918(1)	1031	66	277
		Nov.	2	3.4	291		558	60	220
		Dec.	2	4.3	160		248	32	112
	Mouth - Mile 0.5	Nov.	3	4.9(2)	15 (2)		40 (2)	2.8(2)	13
		Dec.	3	5.8(2)			12 (2)		4.0
Harmon Creek Mi.66.7 Bel. Pgh.	Mouth - W.Va. Rt. 2 Mile 0.2	Nov.	3	2.8	244		336	24	80
		Dec.	3	2.6	314		415	24	59
Piney Fk. of Short Cr.-Mi.81.3 Below Pittsburgh	Bel. Piney Fork, Ohio Mile 11	Nov.	3	4.9(1)	85 (1)		151 (1)	6.0(1)	56 (1)
Wheeling Creek Mi.90.2 Bel. Pgh.	Abv. Barton, Ohio Mile 10.7	Oct.	2	3.4	87		107	7	26
	Bel. Barton, Ohio Mile 9.2	Sept.	1	4.7	49	185	161	57	72
		Oct.	2	3.4	147		174	7	43
Little Muskingum R. Mi. 168.3 Bel.Pgh.	Mouth - Mile 0.1	Aug.	5	5.6(2)		10(2)	6 (2)		0.4
		Sept.	5	5.2(3)	4 (1)	9(3)	5 (3)		0.4
Duck Cr.-Mi.170.6 Below Pgh.	Mouth-Mile 0.2	Aug.	11	5.9(1)		9(1)	3 (1)		
		Sept.	5	5.2(1)		8(1)	4 (1)		0.1(1)

Note:- Figures in parentheses indicate number acid samples used in computing averages as shown.